OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIII 1937 Number 10

A Check List of the Syrphidae of Oceania

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INTRODUCTION

The purpose of this paper is to present as completely as possible a catalog or check list of the flies of the family Syrphidae having an insular distribution in the Pacific region. I am greatly indebted to Mr. E. P. Mumford, Director of the Pacific Entomological Survey, for the opportunity of presenting this study on a region interesting from both a distributional and ecological point of view. The area studied is limited to the Marianas, the Carolines, and Fiji on the west; to Hawaii on the north; to Easter Island on the east; and to the Kermadecs on the south. For minor records or citations of species in the literature, the student is further referred to the complete and excellent summary of records for Hawaii by Mr. E. H. Bryan, Jr. (6)[1].

The present paper lists 35 valid species from the region which are distributed among 18 genera. All records of introduced or intercepted species of which I am aware have been included. The accompanying table summarizes the distribution of 13 large genera as well as unique or peculiar genera, including the number of species known at the time of the preparation of this paper, within several subregions of continental Asia, Oceania, Malaya, Australia, and New Guinea. For the purposes of the table, Malaya is taken to include the Malay Peninsula, Sumatra, Borneo, Java, the Philippine Islands, Celebes and Bali. Oceania is primarily considered as the restricted

[1] Numbers in parentheses refer to Literature Cited, p. [illegible].

region treated in this paper, but for comparative purposes, in the table only, it is also considered in a broad sense as including New Guinea, Australia, New Caledonia, New Zealand, the Antipodes, and Galapagos. The figures given for the continent of Asia exclude the more remote sections such as Korea, Saghalin, Siberia, Arabia, and the islands of Formosa and Japan, from which islands several hundred species of Syrphids have been recorded in recent years, constituting an extraordinarily rich fauna.

The table indicates that the genera *Syrphus, Eristalis* (including *Lathyrophthalmus*), and *Eumerus* furnish the largest components of the Syrphid fauna of the restricted Oceanic region; while these same groups are also the most prominent of the continent and Malayan regions, nevertheless, the percentage components show *Syrphus* species to be most strongly represented in the Pacific islands and *Helophilus* species to be more than twice as well represented in Oceania, in the broad sense, as in the continental region. The absence of such characteristically Malayan genera as *Milesia, Korinchia,* and of such almost world-wide genera as *Sphegina, Rhingia, Mallota, Volucella* (except introduced species) in the Oceanic region is noticeable. It is also notable that while *Syrphus* species are largely endemic the species of the very closely related genus *Asarkina* are abnormally widespread. The same relationship appears to hold with regard to *Eristalis* and *Phytomia* species. It is perhaps odd that *Eristalis nitidus* Van der Wulp should be recorded from Java and Sumatra on the one hand, and from Fiji and Samoa on the other, but not from New Guinea or Australia. There are 26 Malayan species occurring in the expanded Oceanic region but only 3 in the restricted Oceanic region.

The generic names given in parentheses after a number of species in the check list are the names under which these species have been discussed by previous authors.

Distribution of Syrphidae in Eastern Asia and Oceania

Genera Considered	Malaya	Continent of Asia	Species Common to Continent and Malaya	Total of Species of Continent and Malaya	Total of Species of Expanded Oceanic Region	Australia	New Guinea	Oceania	Species Listed from Oceania and Malaysia	Percent of Oceanic Species Found in a Single Genus	Percent of Malasian Species Found in a Single Genus
Syrphus	30	25	0	55	36	19	7	7	0	20.0	8.5
Cerioides	9	28	0	37	23	17	5	0	0	—	5.7
Microdon	24	16	2	38	28	19	9	0	0	—	5.9
Eristalis	54	50	6	88	40	20	21	6	2	17.1	13.6
Xylota	11	11	0	22	7	6	1	0	0	—	3.4
Helophilus	13	4	2	15	16	12	4	0	0	—	2.3
Paragus	2	7	1	8	8	3	5	0	0	—	1.2
Eumerus	10	18	1	27	13	7	4	3	1	8.5	4.2
Syritta	5	4	1	8	5	2	2	1	0	2.8	1.2
Dissoptera	1	0	0	1	4	2	2	2	0	5.7	1.5
Baccha	35	11	1	45	11	2	7	1	0	2.8	6.9
Milesia	27	11	1	37	0	0	0	0	0	—	5.7
Graptomyza	17	4	0	21	9	5	3	1	0	2.8	3.2
Unique Genera	7	5	2	14	11	9	2	1	0	—	—

Total number of species known from Oceania 35
Total number of species known from the Pacific islands outside of the Oceanic area studied 259
Total number of species known from Malaya 323
Total number of species known from the continent of Asia (southeastern part) 321

CHECK LIST

Genus MELANOSTOMA Schiner, 1860

1. **Melanostoma stegnum** Say: 33, vol. 6, p. 163; 6.
Hawaii; intercepted in quarantine; an American species not known to be established.

2. **Melanostoma univittatum** Wiedemann: 48, pp. 34, 53, 64; 2; 8; 9; 10; 11; 20; 21.
Australia, Fiji, Samoa, Malay, Tonga, New Caledonia.

Genus ASARKINA Macquart, 1841

3. **Asarkina consequens** Walker: 47, vol. 1, p. 18; 8; 10; 11; 27.
New Guinea, Malay, Samoa, Java, Sumatra, Celebes.

4. **Asarkina ericetorum** Fabricius: 13, vol. 2, p. 425; 2; 11; 20; 21; 27.
Bezzi describes the variety *papuanum* from New Guinea and Fiji and the variety *oceanicus* from Fiji. See also the extensive notes of De Meijere (27, p. 311).
New Guinea, Java, Sumatra, Fiji, Samoa, Australia.

Genus SYRPHUS Fabricius, 1775

5. **Syrphus corollae** Fabricius variety **vitiensis** Bezzi: 2, p. 71; 20; 21.
Fiji, Samoa, Australia ? (Hardy, 20).

6. **Syrphus melanurus** Bigot: 3, ser. 6, vol. 4, p. 97.
Listed as a synonym of *Ischiodon scutellaris* Fabricius by Bezzi.
New Caledonia, Society Islands.

7. **Syrphus nodalis** Thomson: 41, p. 497; 2.
Listed as a synonym of *Ischiodon scutellaris* Fabricius by Bezzi.
"Taiti".

8. **Syrphus opinator** Osten Sacken: 32, vol. 3, p. 327; 6.
Hawaii; a North American species which was intercepted and bred; I can find no record of its having become established.

9. **Syrphus rectus** Nowicki: 31, vol. 2; 22.
Listed as a synonym of *S. ortas* Walker by Kertesz (23).
Polynesia.

10. **Syrphus novae-selandiae** Macquart: 26, suppl. 5, p. 95, 1855; 28.
New Zealand, Kermadec Islands, Chatham Islands, [Hutton (28) records it from Polynesia].

11. **Syrphus (Epistrophe) viridiceps** Macquart: 26, suppl. 2, p. 61, 1847; 7; 20; 24; 27; 28.
New South Wales, Kermadec Islands, Australia.

Genus ALLOGRAPTA Osten Sacken, 1876

12. **Allograpta obliqua** Say: 33, vol. 3, p. 89; 6; 40.
Hawaii; an American species intercepted in quarantine.

Genus SPHAEROPHORIA St. Fargeau, 1825

13. **Sphaerophoria annulipes** Macquart: 26, suppl. 5, p. 96, 1855; 34. (*Melithreptus*).
Marquesas Islands, Society Islands.

Genus XANTHOGRAMMA Schiner, 1860

14. **Xanthogramma amphoterum** Bezzi: 2, p. 74; 1; 21.
Fiji, Marquesas Islands, Tahiti.

15. **Xanthogramma javanum** Wiedemann: 48, pp. 34, 53; 2; 4; 8; 10; 11; 20; 21; 27; 36 (*Syrphus, Spaerophoria*).
New Guinea, Malay, Australia, Fiji.

Genus SIMOSYRPHUS Bigot, 1882

16. **Simosyrphus grandicornis** Macquart: 26, vol. 2, p. 96, 1842; 2; 5; 7; 9; 20; 24; 40; 45 (*Syrphus, Xanthogramma* of authors).
Listed as a synonym of *Ischiodon scutellaris* Fabricius by Bezzi (2).
Hawaii, Johnston Island, Fiji, Queensland, New Caledonia.

Genus ISCHIODON Sack, 1913

17. **Ischiodon scutellaris** Fabricius: 15, p. 252; 1; 2; 4; 6; 8; 9; 10; 20; 21; 27; 36. (*Scaeva, Syrphus, Sphaerophoria, Xanthogramma*).
See Brunetti (4) for the extensive synonymy of this species. Note, however, Bezzi's addition of *Xanthogramma aegyptius* and *Simosyrphus grandicornis* Macquart in the synonymy of this species.
Hawaii, Johnston Island, Wake Island, Marianas Islands, Australia, India, Malay, New Guinea, Tahiti, Marquesas Islands.

Genus MESOGRAMMA Loew, 1865

18. **Mesogramma marginatus** Say: 33, vol. 3, p. 92; 6.
Hawaii; introduced.

Genus BACCHA Fabricius, 1805

19. **Baccha praefica** Bezzi: 2, p. 76; 21.
Fiji.

Genus VOLUCELLA Geoffroy, 1764

20. **Volucella obesa** Fabricius: 12, p. 763; 1; 2; 6; 21; 23.
Introduced into Fiji, Samoa, Hawaii, Tahiti, Marquesas.

21. **Volucella pusilla** Macquart: 26, vol. 2, pp. 2, 21, 1842; 6; 39.
Hawaii; introduced.

Genus GRAPTOMYZA Wiedemann, 1820

22. **Graptomyza uchiyamae** Shiraki: 36, vol. 1, pp. 1-446.
Marianas Islands.

Genus ERISTALIS Latreille, 1804

23. **Eristalis (Lathyropthalmus) aeneus** Scopoli: 35, p. 356; 6.
Hawaii; intercepted.

24. **Eristalis (Lathyropthalmus) arvorum** Fabricius: 14, vol. 2, p. 335; 4; 6; 7; 8; 10; 11; 17; 27.
Fulvipes Macquart-*arvorum* Fabricius [Brunetti (4)].
Hawaii, Queensland, Bengal, Java, Sumatra, China.

25. **Eristalis (Lathyropthalmus) nitidus** Van der Wulp: 43, p. 38; 2; 21; 27.
Java, Sumatra, Fiji, Samoa.

26. **Eristalis punctulatus** Macquart: 26, suppl. 2, p. 259; 6; 9; 17; 19; 24; 27.
Ferguson (17, pt. 1), following Hardy (19), lists *Eristalis agno* as a synonym of *E. punctulatus.*
Australia, Tasmania, Hawaii, New Caledonia.

27. **Eristalis rhynchops** Bezzi: 2, p. 80.
Fiji.

Genus DISSOPTERA Edwards, 1915

28. **Dissoptera maritima** Hull: 21, p. 196.
Samoa.
29. **Dissoptera unicolor** Bezzi: 2, p. 77.
Fiji.

Genus AXONA Walker, 1864

30. **Axona chalcopyga** Wiedemann: 49, vol. 2, p. 178; 8; 10; 11; 36; 44.
New Guinea, Malay, Marianas Islands.

Genus MERODON Meigen, 1803

31. **Merodon equestris** Fabricius: 12, vol. 4, p. 292; 6; 28.
New Zealand, Hawaii (bred but not known to be established).

Genus SYRITTA St. Fargeau and Serville, 1828

32. **Syritta oceanica** Macquart: 26, suppl. 5, p. 112; 1; 2; 6; 28.
New Zealand, Tahiti, Marquesas Islands.
Bigot credits to Tahiti and New Zealand (Miller, 28); Hutton (22, 1881) did not believe it occurred in New Zealand, but it has been recorded from there since. Possibly the "Taita" of New Zealand has been confused with Tahiti.

Genus EUMERUS Meigen, 1822

33. **Eumerus hemipterus** Bezzi: 2, p. 82.
    Fiji.
34. **Eumerus marginatus** Grimshaw: 18, vol. 3, p. 82; 6; 8; 11; 19.
    Hawaii, Malaysia.
35. **Eumerus strigatus** Fallen: 16, p. 61; 6.
    Hawaii; intercepted and bred but not known to be established.

Eupeodes volucris Osten Sacken, an American species, was introduced into Hawaii for aphid control, but apparently did not become established (6). An additional American species, *Syrphus wiedemanni* Johnson, was noted by Osborn under the name *S. americanus* Wiedemann (Hawaiian Ent. Soc., Proc., vol. 4, p. 333, 1920).

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OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIII | August 1, 1937 | Number 15

A New Species of Hawaiian Portulaca

By FRANK E. EGLER

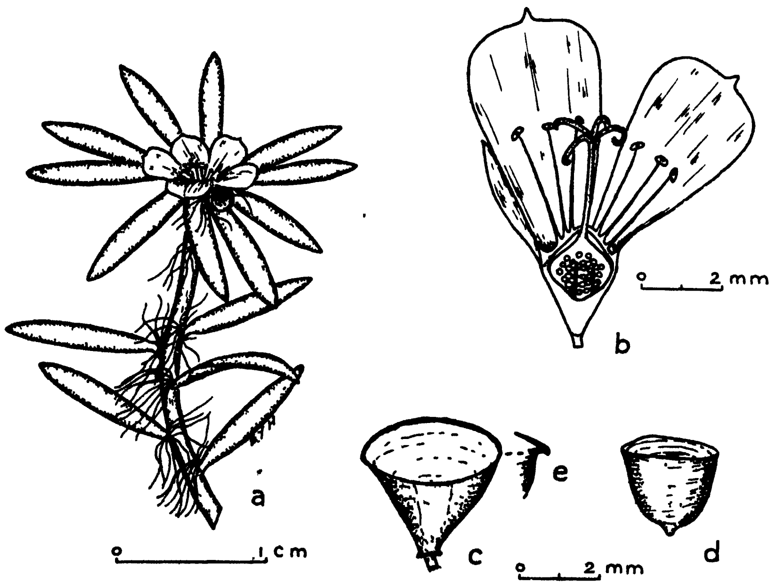
BISHOP MUSEUM FELLOW 1936-37

Portulaca cyanosperma, new species (figs. 1 and 2).

Perennis vel annua, prostrata vel suberecta, carnosa, herbacea, ramosa. Caules teretes, 2 usque 3 ∅, saepe rubri, cum pilis axillaris vel fere glabri. Folia alterna, subulata, teretes vel plana, 3-22 mm. longa. Flores apicibus ramorum conferti, sessiles vel fere sessiles, pilis multis cincti, folias subinvolucralias cincti. Sepala 2, 2-3 mm. lata, 3 mm. longa, haud carinata. Petala rosea, 4-5, obovata vel obcordata, 5-6 mm. longa, 3-4 mm. lata, apice emarginata apiculataque. Stamina 6-17. Filamenta rubra, 2.5-3.0 mm. longa. Stylus ruber; stigmates 2-5, rubra, 1.5 mm. longa. Capsula medio vel infra medium circumscissa, macra-chartacea, 3-5 mm. longa. Semina leviter nitida, caerulea metallica, 0.5 mm. longa, a latere compressa, suborbiculata, non lineis rugosis sed subtuberculatis.

A segregate from *Portulaca villosa* Chamisso, to which it is similar. Prostrate or semi-erect, fleshy, herbaceous, branching annual or perennial. *Stems* terete, 1.5-3.0 mm. in diameter; purplish red, or greenish on new shoots or where sheltered from light by overlying shoots. From almost glabrous to pilose, with long white axillary matted hairs about 5 mm. long. Pilosity variable on the same individual and probably variable at different seasons, under different conditions, and in different populations. *Leaves* alternate; awl-shaped; variable, narrowly lanceolate, elliptical, or oblanceolate; closing against the stem at night. *Petiole* 1-2 mm. long, pale green in color. *Blades* 3-22 mm. long, generally 10 mm.; 1-3 mm. wide, generally 2 mm.; and 0.5-1.0 mm. thick. Blades flattened or rounded in cross section; greenish or dark reddish in color; surface finely reticulate with darker lines. *Inflorescence* terminal; surrounded by a ring of terminal involucroid leaves, slightly larger than the cauline leaves. Copious white hairs, 1 cm. long, surrounding the flowers. *Flowers* ephemeral, opening in the morning, closing before noon; sessile or minutely stalked, about 7 mm. in diameter. *Sepals* keelless; 2-3 mm. wide, 3 mm. long; with thin scarious margins 0.5 mm. wide. *Petals* 4-5, usually 5; deep rose color; obovate or slightly obcordate; 5-6 mm. long, 3-4 mm. wide; minutely apiculate with a deltoidal point 0.2 mm. long. *Stamens* 6-17, varying in number on the same plant, with the extremes in number equally abundant. *Filaments* dark red; 2.5-3.0 mm. long, united at the base in a very short, pale green ring which is contracted over the ovary and surrounds the base of the style. *Anthers* yellow;

0.5 mm. long. *Stigmas* 2-5, usually 4; dark red; 1.5 mm. long; minutely papillose. *Style* dark red, 2.5-3.0 mm. long. *Ovary* one half to two thirds inferior; 1.5-2.5 mm. long; with 3-5 free central placentae; petals, sepals, and stamen ring arising at the place of dehiscence of the mature fruit. *Fruit* a broad-ellipsoid capsule; transversely circumscissile at or below the middle at the place of greatest diameter; readily dehiscing, leaving the cup characteristically attached. *Operculum* greenish-yellow; thin-chartaceous; flexible; 2-3 mm. long, 2-3 mm. wide; bluntly rounded in silhouette; tipped with minute base of the style and usually incased in the dry persistent floral parts. *Cup* thicker in texture than the operculum; light brownish; from saucer-shaped to short-obconical to short-stemmed goblet-shaped. Cup 2-3 mm. in height; with minute flaring rim. *Seeds* numerous; asymmetrically orbicular, compressed laterally; shining; 0.5 mm. in length; slightly variable in size; when seen in mass distinctly blue in color, under magnification with metallic lustre; margin appearing minutely tuberculate; surface with 4-5 concentric rows of slightly raised, stellate tubercles, more pronounced near the margin.



sperma

FIGURE 1.—[redacted]*tulaca cyano*[redacted]: *a*, flowering shoot; *b*, longitudinal section of the flower; [redacted]base of capsule; *d*, operculum; *e*, section of rim of capsule base, enlarged.

Lehua: April 18, 1931, *Caum 1*; April 19, 1931, *Caum 12* (type, Bishop Museum).

Kauai: Barking Sands, Feb. 11, 1922, *Skottsberg 1062*; Kekaha, sandy flat, alt. 30 ft., Dec. 24, 1933, *St. John, Fosberg, and Oliveira*

13614; Barking Sands, on sand dunes and sand flat, alt. 15 ft., Dec. 31, 1935, *Fosberg 12735*; a collection by *Otto Degener,* considered by him a novelty, not seen by author, probably *P. cyanosperma.*

Oahu: Manoa Valley, June 30, 1937, *Egler 37-59,* cultivated plant of *Caum 12* (cotype).

Portulaca cyanosperma is presumably endemic to Kauai and the nearby islet of Lehua; *P. villosa* Chamisso is not known to occur on these islands.

FIGURE 2.—Seed of *Portulaca cyano~~carpa.~~* sperma

Portulaca cyanosperma is closely related to *P. villosa* (as exemplified by *Egler 37-65,* Koko Head, Oahu, May 19, 1937). It differs in being regularly smaller in all proportions and in having red pigment consistently prominent in stems, leaves, and floral parts. The ovary is more inferior and due to the contraction of the filament ring, is invisible in the open flower, whereas the white or pink ovary of *P. villosa* is apparent. The filament ring of *P. cyanosperma* is pale green in color and loosely contracted over the ovary, not adaxially yellow and tightly appressed. Stamens are fewer in number, 6-17, not 26-44. Stigmas 2-5, not 5-7. Filaments, style, and stigmas are red,

not white; petals dark rose, not pale pink and white. The operculum is consistently smaller, thinner in texture, more flexible, rounded in silhouette, not angled and flat-topped. Seeds metallic blue, not black; slightly shiny and reflecting light, not dull; with tuberculate margin, not with entire margin; with slightly raised tubercles on the surface, not deeply rugose and not showing flat stellate bodies.

The species is described on the basis of the collections of *Portulaca* in Bishop Museum and of living material of the new species, grown in Honolulu by E. L. Caum of the Hawaiian Sugar Planters' Association Experiment Station, appreciation for the use of which is here extended. The photograph was taken by Mr. W. Twigg-Smith, through the courtesy of the Experiment Station.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIII August 5, 1937 Number 16

A New Species of Trisetum and a New Variety of Panicum imbricatum from the Hawaiian Islands

By LEO D. WHITNEY

HAWAII AGRICULTURAL EXPERIMENT STATION.

Trisetum inaequale, new species (fig. 1).

Perenne, culmi caespitosi 30-40 cm. alti glabri, vaginae 5-15 mm. longae glabrae vel hispidulae, ligulae 1 mm. longae, laminae involutae 20-30 cm. longae glabrae, paniculae 3-6 cm. longae, spiculae 6-7 mm. longae 1-3-floriferae, glumae inaequales glabrae cum carinis scabris primae 3.5-3.7 mm. longae 1-nervosae angustae acuminatae secundae 4.5-6 mm. longae 3-nervosae acutae, lemmae scaberulae 5-6 mm. longae aristae 1-2 mm. longae, palea 3 mm. longae.

Tufted perennial; culms 30-40 cm. tall, glabrous; sheaths extremely short, 1-2 cm. long, striate, glabrous or hispidulous, lower ones chartaceous; ligule 1 mm. long, membranous; blades involute, usually almost capillary, strikingly elongate, often extending beyond the panicle, 20-30 cm. long, usually glabrous but occasionally scaberulous within; panicles 3-6 cm. long, compact, spike-like, globose, shining, silvery or tawny, rachis villous; spikelets 6-7 mm. long, loosely 1-3-flowered, in close clusters; glumes transparent except the nerves, keeled, scabrous on keel but otherwise glabrous, unequal; first glume 3-3.7 mm. long, 1-nerved, narrow, acuminate, 0.3-0.5 mm. from keel to margin; second glume 4.5-5 mm. long, 3-nerved, broad, acute, 0.7-1.0 mm. from keel to margin; lemmas 4-6 mm. long, scaberulous, with a delicate straight awn 1-2 mm. long borne on the back 0.7-1.5 mm. from the minutely bifid apex, rachilla sparsely villous; palea 3 mm. long, exposed, shining, scaberulous on keel; anthers narrow, 1-1.2 mm. long, yellow; stigmas 1-1.5 mm. long, silvery, plumose.

Hawaiian islands: Lanai, Kaohai, March 19, 1916, *G. C. Munro 264*; West Maui, Olowalu Valley, left-hand ridge at edge of *pali,* May 10, 1920, *C. N. Forbes 2296* (type in Bishop Museum).

This new species comes closest to the Hawaiian *Trisetum glomeratum* (Kunth) Trin. and the Arctic alpine *Trisetum spicatum* (L.) Richt. of Europe and America. The new species can be distinguished from these two by the following characters. *Trisetum glomeratum*

FIGURES 1-2.—*Trisetum inaequale* and *Panicum imbricatum* var. *oreoboloides*. 1, *Trisetum inaequale*: *a*, habit view; *b*, spikelet; *c*, glumes; *d*, floret; 2, *Panicum imbricatum* var. *oreoboloides*: *a*, habit view; *b*, spikelet.

has its glumes equal or nearly so; the first glume 4.7-6 mm. long and 0.7 mm. from keel to margin; the second glume 5-6 mm. long and 1 mm. from keel to margin; panicles 10-20 cm. long; leaf sheaths 4-12 cm. long; blades thick-coriaceous, 10-25 cm. long, 2-7 mm. wide. *Trisetum spicatum* has its first glume 3-4 mm. long; second glume 3.5-5 mm. long; lemmas with rather stout geniculate awn borne on the back 1.7-2.2 mm. from apex; blades 5-15 cm. long, 2-5 mm. wide. *Trisetum inaequale* has its glumes decidedly unequal; the first glume 3-3.7 mm. long and 0.3-0.5 mm. from keel to margin; the second glume 4.5-5 mm. long and 0.7-1 mm. from keel to margin; lemmas with a straight delicate awn borne from the back 0.7-1.5 mm. from apex; panicles 3-6 cm. long; leaf sheaths 1-2 cm. long; blades delicate, involute, 20-30 cm. long.

Panicum imbricatum Hillebr. var. **oreoboloides,** new variety (fig. 2).

A *P. imbricatum* laminae involutae rigidae in superficibus tomentosae differunt.

Hawaiian islands: Kauai, Wahiawa Swamp, August 1909, *C. N. Forbes 184* (type in Bishop Museum).

This variety differs from the species in having involute, rigidly erect leaf blades that are densely villous within. It is named in allusion to its striking resemblance to the sedge, *Oreobolus furcatus* H. Mann.

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIII | 1937 | Number 17

Ecological and floristic studies in Kipapa Gulch, Oahu*

By EDWARD Y. HOSAKA

INTRODUCTION

This investigation concerns the ecological and floristic features of Kipapa Gulch, Koolau Range, a mountain valley extending from near the middle of the range at an elevation of 860 meters, to sea level at Pearl Harbor, a distance of about 21 kilometers. It was chosen as typical of approximately one quarter of the island. It is one of the larger gulches and has a well preserved mountain flora. More specifically, the objects of study have been to determine the species of plants which are growing naturally at different elevations in this valley, together with an experimental investigation of environmental conditions, as well as a survey of the composition, distribution, and successional relations of the various plant communities. The work was initiated in the fall of 1931 and carried on during the following four years. The climatic and edaphic data were gathered in 1933.

Very few ecological studies of vegetation have been made in Hawaii. Early explorers, Wilkes (66),[1] Bloxam (5), Byron (7), Chamisso (11), Menzies (37), and Seemann (53), give only short observational accounts of the vegetation. Hillebrand (23) takes up the ecology of the Hawaiian islands in general and divides the plants into groups occupying different elevations. The more recent workers are Forbes (19), Rock (44), Campbell (10), and MacCaughey (30). Forbes deals with plant succession on new lava flows, Rock with vegetational zones, Campbell with environment, and MacCaughey with associations.

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* Presented in partial fulfillment of the requirements for the degree of Master of Science, University of Hawaii, 1935.

[1] Numbers in parentheses refer to Bibliography, p. 230.

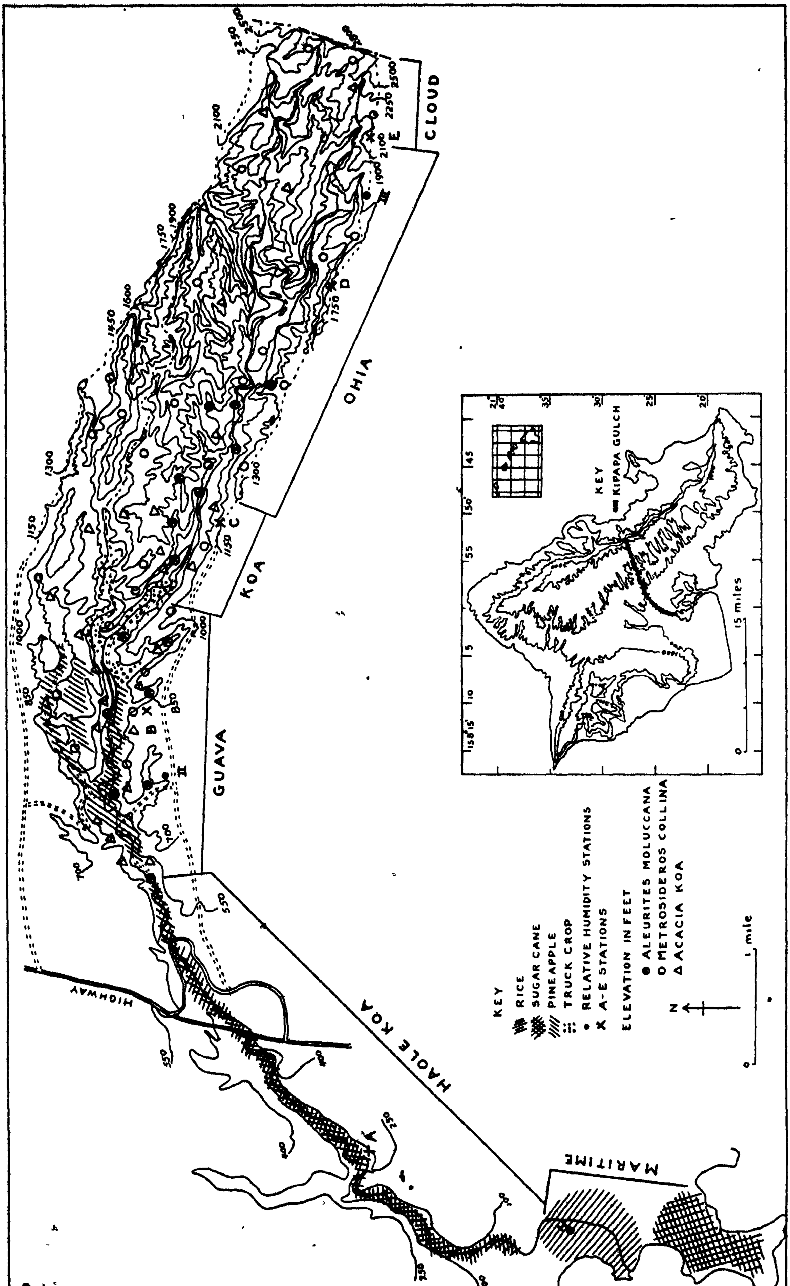

FIGURE 1.—Map of Kipapa Gulch showing topography, stations where data were collected, and distribution of important trees.

The only detailed ecological study of a specific area in Hawaii was made by MacCaughey (30). Before this study, the ecological investigations comprised only a general description of the vegetation.

Acknowledgments

These studies have been conducted under the direction of Professor Harold St. John of the University of Hawaii to whom I express my appreciation for the aid and counsel given during the progress of the problem. I also express my appreciation to Dr. Herbert E. Gregory, Director Emeritus of Bernice P. Bishop Museum, for use of the herbarium, and to Mr. Edwin H. Bryan, Jr., Curator of Collections, for his unfailing encouragement. Furthermore, I acknowledge my indebtedness to Mr. E. B. Bartram for naming the mosses, to Dr. Oscar C. Magistad for the use of the organic content determination apparatus, to Dr. Walter Carter for the loan of atmometers and to Mr. J. F. Voorhees for the use of a sling psychrometer. I also thank Mrs. Beatrice M. Hosaka for typing the paper, Mr. Michio Yamaguchi who has been an unselfish field companion and frequent assistant on most of the trips taken during the progress of the study, Mr. F. R. Fosberg who has been a pleasant field companion on some of the trips, and last but not least Dr. G. E. Nichols and Dr. F. E. Egler for reading and commenting on this paper.

Physiography

Kipapa Gulch is located on the west slope of the Koolau Range, which runs northwest to southeast from one end of the island to the other (fig. 1). The gulch extends approximately 21 kilometers from the West Loch of Pearl Harbor to the summit area of the Koolau Range, and is one of the longest gulches on the island of Oahu. The region from the shore of West Loch for about 800 meters to the mouth of the entrenched gulch is of level alluvial land. The larger portion of this section is utilized for rice growing. There are several fish ponds varying in size from a few acres to several acres close to the beach and small patches of taro fields and vegetable gardens along the fringe of the rice fields.

The gulch extends northward for a short distance, turns northeast and then eastward toward the summit range. The width and depth of the gulch vary considerably. The gulch at its mouth is narrow with steep rocky sides, but a few hundred meters inland, it

becomes broader with less steep sides. On the gulch bottom are flood plains ranging in size from a few to many acres. This region with nearly level floor and gently sloping sides extends to about 225 meters elevation and is cultivated. The lower third of this agricultural land is planted in sugar cane and the upper two thirds is cultivated in pineapple and truck crops (fig. 2).

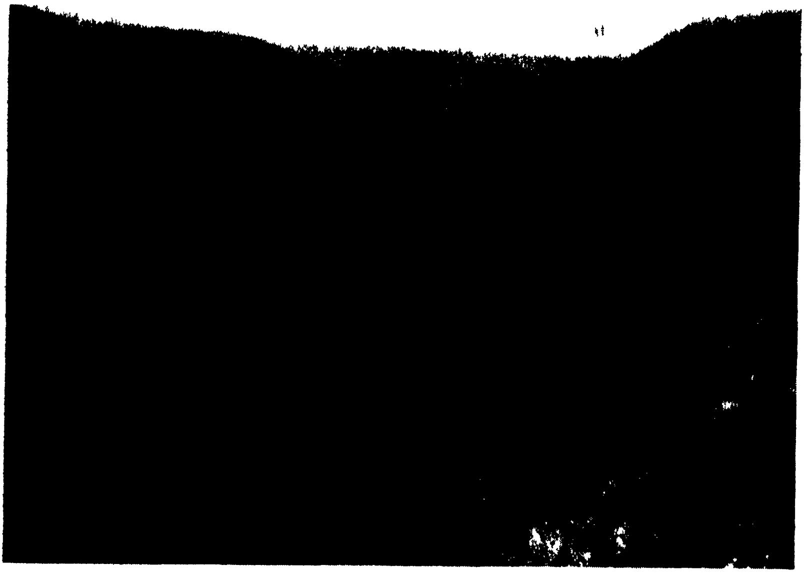

FIGURE 2.—View downstream in the Guava Zone showing cultivated fields, *Psidium Guayava, Heteropogon contortus* on the foreground slope, and banana plantation on the bottom.

Above 225 meters elevation, the slopes are entrenched by many narrow gullies that run obliquely to the main gulch. The few side gullies radiating from the main gulch below the 225 meters elevation are also oblique. This much dissected section is thickly forested with many species of native ferns, shrubs, and tall trees.

The depth of the gulch increases with the increase in elevation up to about 200 meters of the summit where the streams descend as cascades and waterfalls from the slope of the summit range. The side streams are intermittent to semi-intermittent in flow and supply the central stream which is usually permanent in flow. Its lower section. below the forest, occasionally dries up after a long drought.

The central or main stream meanders through the gulch to the West Loch cutting across the alluvial land beyond the gulch proper. The stream at this lower portion is fed by springs, and the flow is permanent. On both sides of the gulch at about half way between the bottom and the rim is a bed of basalt, two to seven meters thick, which outcrops in a continuous line in the lower region of the gulch but becomes intermittent as the forest is approached. This narrow strip of basalt outcrop that extends along the center of the gulch slopes has a conspicuous effect on the height of the plants, due to greater moisture and deeper soil below the outcrop. The plants growing below the outcrop are taller and more vigorous than the same species growing above it.

Plant Zones

In Kipapa Gulch, the plant life shows striking differences in its various parts, due mainly to the wide range of ecological conditions that exist between those of the seaward portion and those of the summit area. Variations occur not only in the composition of the vegetation but also in the habit of individual species. For example, the most common introduced plant, *Psidium Guayava* (guava) thoroughly naturalized in Hawaii, is only a small bush of about 1.2 meters high in the xerophytic lowland region, but it gets much larger in stature and in the diameter of the trunk as the mesophytic region is reached. Here it attains a height of 6.5 to 8.5 meters and a diameter of 15 to 25 cm., but again the species becomes smaller and less common as the wet summit region of the Koolau Range is reached.

For purposes of field investigation and for the presentation of data, six plant zones have been tentatively established in Kipapa Gulch. These are recognized wholly on the basis of existing cover types. Any other classification taking into account the phyto-climate, the pre-existing vegetation, or the ultimate plant cover is not yet possible in the present state of knowledge.

The Maritime Zone vegetation is chiefly composed of salt-loving plants such as *Batis maritima, Sesuvium Portulacastrum,* and *Scirpus maritimus.* On waste places, particularly on drier sites, *Prosopis chilensis* and *Panicum purpurascens* are conspicuous. In the lower section of the gulch, in the Haole Koa Zone, the plants are mostly xeric. Some of the dominating species are *Leucaena glauca* (haole

koa), *Opuntia megacantha, Acacia Farnesiana, Lantana Camara,* and *Heteropogon contortus.* Farther up the gulch, in the Guava Zone, *Psidium Guayava* and *Lantana Camara* are most common. Above this region is the Koa Zone, dominated by *Acacia Koa* and *Gleichenia linearis* on the slopes, and by *Aleurites moluccana* in the gully bottoms. The central portion of the native forest, the Ohia Zone, is dominated by *Metrosideros collina* (ohia lehua), a tree towering 15 meters or more above the ground. The Cloud Zone is characterized by low, dwarfed shrubs in more sheltered parts and by mat-forming *Panicum, Paspalum, Isachne,* and mosses in exposed windswept areas. The vegetation of Kipapa Gulch is more fully treated on page 190.

ENVIRONMENTAL FACTORS

The climatic and edaphic factors determine the vegetation of a region. To determine the various environmental conditions that affect the plants of this region, the atmospheric temperature, relative humidity, rainfall, evaporation, soil temperature, soil moisture, soil acidity, and the organic content of the soil were investigated in the different vegetational zones. The stations where these observations were made were designated as Stations A, B, C, D, and E from the Haole Koa to the Cloud Zones respectively. Their location is shown on the map (fig. 1).

The various climatic and edaphic factors at the stations were recorded at certain times of selected days during 1933. The evaporation and rainfall data of Station A were recorded at 6:00 a.m., B at 6:30 a.m., C at 8:30 a.m., D at 10:30 a.m., and E at 11:45 a.m. The atmospheric temperature and soil temperature data of Station A were recorded at 4:30 p.m., B at 4:00 p.m., C at 3:30 p.m., D at 1:45 p.m., and E at 12:00 m. The times of recording the above factors are approximate varying about 30 minutes on either side of the stated hour, since it was often very difficult to travel through the forest. The relative humidity data were recorded simultaneously at three different places.

Station A is in the Haole Koa Zone at 75 meters elevation on a north facing slope. In the immediate vicinity of the station are a few fairly large stands of *Opuntia megacantha* and sparse growth of *Psidium Guayava, Lantana Camara, Heteropogon contortus, Cassia Leschenaultiana,* and *Waltheria indica* variety *americana.*

Station B is in the Guava Zone at 225 meters elevation on a north facing slope. Around the station are a few trees of *Metrosideros collina* and scattered bushes of *Psidium Guayava, Wikstroemia oahuensis, Lantana Camara, Styphelia Tameiameiae,* and low plants of *Chrysopogon aciculatus, Paspalum orbiculare,* and *Stenoloma chinensis.*

Station C is in the Koa Zone at 305 meters elevation on a north facing slope. Around the station is a thick stand of *Stenoloma chinensis* and *Gleichcnia linearis.* Several trees of *Metrosideros collina, Psidium Guayava, Styphelia Tameiameiae,* and *Acacia Koa* are also found near by.

Station D is in the Ohia Zone at 485 meters elevation on the north facing slope. Around the station are dense stands of *Metrosideros collina, Straussia kaduana, Bobea elatior, Acacia Koa,* and *Gleichenia linearis.* Also many species of ferns and mosses are found on the ground and on tree trunks.

Station E is in the Cloud Zone at 670 meters elevation on the north facing slope. Around the station are many dwarfed trees of *Suttonia Lessertiana, Metrosideros collina, Straussia kaduana,* and *Fagara oahuensis.* Other plants in the vicinity are *Gahnia Beecheyi, Peperomia membranacea, Vaccinium dentatum, Elaphoglossum reticulatum, Gleichenia emarginata, Hymenophyllum recurvum,* and mosses.

Atmospheric Temperature

The atmospheric temperature was recorded at the A to E Stations on March 19, April 2, 9, 16, July 2, 9, 16, 23, 30, November 5, 12, 19, and 26. The data are presented in table 1. The average temperature readings in degrees centigrade at Station A is 29.2, at B, 25.0, at C, 24.0, at D, 22.0, and at Station E, 21.5. The readings indicate that the temperature at the various stations fluctuates on different days at the same hour. At Stations A, B, and C, the temperature in July is much higher than in March, April, or November, but at Stations D and E there seems to be no indication of a month with decided high temperature. The first three stations are below the native forest while the last two are in the forested region.

Table 1. Atmospheric temperature in degrees centigrade recorded at Stations during 1933.

Date	Stations				
	A 4:30 p.m.	B 4:00 p.m.	C 3:30 p.m.	D 1:45 p.m.	E 12:00 m.
March 19	25.5	21.5	22.0	19.0	20.0
April 2	25.5	24.0	23.0	20.0	18.0
April 9	26.5	23.0	23.0	26.5	22.5
April 16	25.5	25.0	23.0	24.0	19.5
July 2	32.0	21.0	21.0	19.2	19.0
July 9	29.5	27.5	26.0	25.0	23.0
July 16	32.0	24.5	23.0	20.5	18.5
July 23	36.0	34.0	29.0	28.0	21.0
July 30	30.0	30.0	30.0	22.5	20.0
Nov. 5		23.0	22.0	25.0	24.0
Nov. 12		24.0	23.0	25.0	22.0
Nov. 19		24.0	24.0	23.0	23.0
Nov. 26		24.0	23.0	17.0	16.0

Since 1905, the atmospheric temperature has been recorded by the Oahu Sugar Company at 61 meters elevation (Haole Koa Zone) and at 205 meters (Guava Zone) in Kipapa Gulch. The data of 28 years (1905-1933) show very little difference in the average annual temperature from year to year. At 61 meters elevation the annual mean temperature fluctuated between 22.3 degrees centigrade and 24.6 degrees centigrade. At 205 meters elevation, the temperature record of 28 years (1905-1933) ranged from 21.3 degrees centigrade to 23.0 degrees centigrade.

Atmospheric Relative Humidity

To determine the relative humidity at different vegetative zones of Kipapa Gulch, wet and dry bulb psychrometers were set up in the open in the Maritime, Guava, and Ohia Zones designated as Stations I, II, and III (fig. 1.), and the readings were made simultaneously from August 5 to 9, 1933. Station I is near the mouth of the gulch on an alluvial flat at an elevation of 3 meters; Station II is on the ridge at an elevation of 200 meters, and Station III is on the ridge in the native forest at an elevation of 550 meters. At Station I, readings were taken at 6:00 a.m. and 7:00 p.m.; at Stations II and III, at 6:00 a.m., 12:00 m., and 7:00 p.m. as tabulated (table 2). The readings for the five days show that the average relative humidity

at Station I is 85 percent, at Station II, 79.8 percent, and at Station III, 92.9 percent.

The rather high relative humidity of Station I might be due to the large body of water near by. Station II is a typical region above the lowland and below the forest so the readings obtained at this zone can be favorably compared with that of Station III, a typical rain forest. The data indicate the average relative humidity of Station III as 14.1 percent higher than that of Station II. The readings also indicate that there is less fluctuation of the relative humidity in the forest than in the open.

Table 2. Relative humidity readings made from August 5 to 9, 1933, at Stations I, II, and III.

Date	Time	Stations I	Stations II	Stations III
		Relative Humidity		
Aug. 5	7:00 p.m.	87.0		100.0
Aug. 6	6:00 a.m.		71.0	95.0
	12:00 m.		72.0	90.0
	7:00 p.m.	87.0	91.0	95.0
Aug. 7	6:00 a.m.	82.0	81.0	92.5
	12:00 m.		72.0	92.5
	7:00 p.m.	83.0	91.0	92.5
Aug. 8	6:00 a.m.	86.0	90.0	97.5
	12:00 m.		67.0	82.0
	7:00 p.m.	87.0	73.0	95.0
Aug. 9	6:00 a.m.	82.0	90.0	90.0

Rainfall

The Koolau Range, with an elevation of 800 meters for the greater part of its length, deflects upward the wind that has absorbed much moisture by blowing over the great expanse of ocean and causes it to lose the moisture in the form of rain. The average annual rainfall of Kipapa Gulch varies from 58.57 cm. at 18 meters elevation to 505.49 cm. at 548 meters elevation. The region usually has a slightly greater precipitation during December to March and a slightly drier season during the summer months; otherwise the rainfall is evenly distributed throughout the year.

There are several permanent rainfall gauges set up at various elevations in Kipapa Gulch and the records of these gauges extend over a period of 9 to 35 years. The average annual rainfall record

of 36 years (1898-1933) at 18 meters elevations in the Haole Koa Zone is 58.57 cm., of 36 years (1898-1933) at 60 meters elevation in the Haole Koa Zone is 61.80 cm., of 17 years (1917-1933) at 115 meters elevation in the Haole Koa Zone is 121.33 cm., of 29 years (1905-1933) at 205 meters elevation in the Guava Zone is 120.62 cm., of 9 years (1925-1933) at 225 meters elevation in the Koa Zone is 200.83 cm., of 5 years (1929-1933) at 548 meters elevation in the Ohia Zone is 505.49 cm.

Temporary rain gauges were set up on March 19, 1933 at Stations A to E (fig. 1) and measurements were made on March 26, April 2, 9, 16, July 9, 16, 23, 30, November 12, 19, and 26. The readings were made at intervals of seven days and each reading is a record of a seven-day period. The data presented in table 3, and the 9 to 35 years' record indicate a greater rainfall with increase in elevation.

Table 3. Seven-day period rainfall in centimeters recorded at Stations A to E during 1933.

Stations	Date										
	Mar. 26	April 2	April 9	April 16	July 9	July 16	July 23	July 30	Nov. 12	Nov. 19	Nov. 26
A	2.54	0.97	0.00	2.54	0.64	0.64	0.33	0.33	......	......	......
B	4.29	1.42	0.76	2.24	1.75	1.27	1.75	2.39	0.15	0.00	0.30
C	5.08	2.24	0.33	2.24	2.87	2.24	2.54	4.45	1.42	0.00	2.54
D	3.66	7.95	1.12	1.42	3.51	2.69	4.14	3.51	1.75	0.00	1.27
E	3.02	9.53	0.25	1.42	7.62	4.45	9.04	8.89	1.27	0.15	5.08

Evaporation

To determine the amount and rate of evaporation in the different vegetational zones, Livingston white sphere atmometers were set up at Stations A, B, C, D, and E (fig. 1). At each station two atmometers were set up, each eight inches above the ground, one in full sunlight and the other in the shade to get the rate of water loss under the two conditions. The atmometers were set up according to Livingston-Thone (28) method, except that the joints of the rubber stopper were coated with melted paraffin. These atmometers were operated from March 19 to April 16, from July 2 to 30 and from November 5 to 26, and the evaporation was recorded every seven days. During the period of operation, an average of 157.93, 124.83, 91.00, 32.07, and 25.67 cc. of water evaporated from the

atmometers placed in the sun at Stations A to E respectively, and an average of 109.61, 107.12, 66.17, 27.14, and 11.97 cc. of water evaporated from the atmometers placed in the shade at the stations in the same order (fig. 3). The following average evaporation in the sun and shade together were obtained at the stations: A, 133.77 cc.; B, 115.97 cc.; C, 78.58 cc.; D, 29.60 cc.; and E, 18.82 cc.

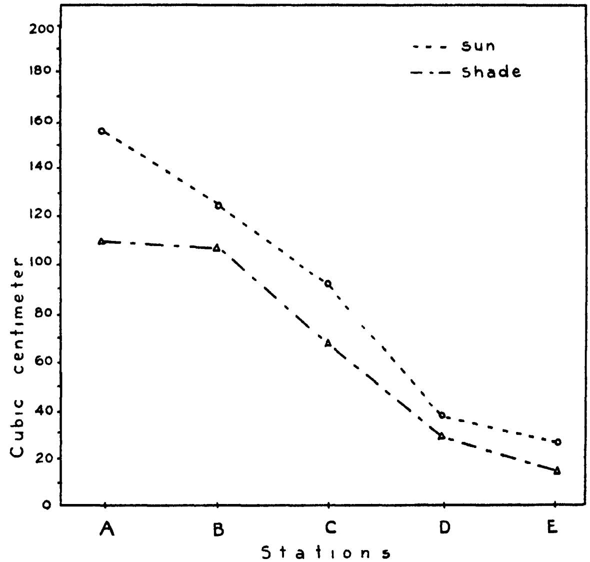

FIGURE 3.—Average evaporation in cc. from bulb atmometers placed in sun and shade at different stations during 1933.

The evaporation from the atmometers in the sun was much greater than that from the atmometers placed in the shade, and the evaporation outside the forest was decidedly greater than evaporation in the forest. The average evaporation for the three Stations, A, B, and C, which are below the native forest was 109.43 cc. while the average evaporation of Stations D and E which are in the native forest, was 24.21 cc.; a ratio of 4.5:1.

SOIL TEMPERATURE

Soil temperatures were taken at Stations A, B, C, D, and E on March 19, 26, April 2, 9, 16, July 2, 9, 16, 23, 30, and November 5, 12, 19, and 26, 1933. The soil temperature reading of Station A was made at about 4:30 p.m., of Station B at 4:00 p.m., of Station C

at 3:30 p.m., of Station D at 1:45 p.m., and of Station E at 12:00 m. The soil temperature was recorded with a thermometer tied to a rod and inserted to 15, 30, 60, and 90 cm. depth in a vertical hole made with a soil auger. The soil auger was screwed in vertically until the 15 cm. mark was reached, then taken out and the thermometer placed in the cavity for approximately three minutes with the bulb of the thermometer in the soil. Then the thermometer was quickly pulled out and the temperature recorded. The same hole was deepened with the soil auger until the 30 cm. mark was reached and again the temperature was recorded in the same manner. The temperature for the 60 and 90 cm. depths was similarly recorded. Each week a new hole was dug with the soil auger and the temperature recorded. The average soil temperature of the readings made on selected days during 1933 of Stations A, B, C, D, and E at 15 cm. depth, were 30.6, 24.0, 22.9, 20.0, and 18.8 degrees centigrade, respectively; at 30 cm. depth, 27.9, 22.8, 22.0, 19.6, and 18.9 degrees centigrade, respectively; at 60 cm. depth, 27.3, 22.6, 21.8, 19.7, and 18.8 degrees centigrade, respectively; at 90 cm. depth, 26.7, 22.5, 21.6, 19.5, and 18.0 degrees centigrade, respectively (fig. 4).

The average soil temperature readings of the depths from 15 to 90 cm. at Station A was 28.1, at B, 22.9, at C, 22.1, at D, 19.7, at E, 18.8 degrees centigrade.

On July 23, 1933, the highest temperature of 36.0 degrees centigrade and on November 26, 1933, the lowest temperature of 17.0 degrees centigrade were recorded for the 15 cm. depth at Stations A and E, respectively.

At 30 cm. depth, the highest temperature of 32.0 degrees centigrade was recorded on July 23 at Station A and the lowest temperature of 17.5 degrees centigrade was recorded on November 26 at Station E. At 60 cm. depth, the highest temperature of 31.0 degrees centigrade and the lowest temperature of 17.0 degrees centigrade were recorded on July 23 and April 9, respectively at Stations A and E. At 90 cm. depth, the highest temperature of 30.0 degrees centigrade and the lowest temperature of 17.0 degrees centigrade were recorded on July 2 and April 9 respectively at Stations A and E.

The data were collected at various times in a single year so they do not justify any definite conclusion on the range of variation of

soil temperature at Kipapa Gulch. However, the data presented here show that the soil temperature decreases with depth and elevation.

Soil Moisture

To obtain data on the moisture content of the soil, soil samples were collected with a soil auger at depths of 0-15, 30, 60, and 90 cm.,

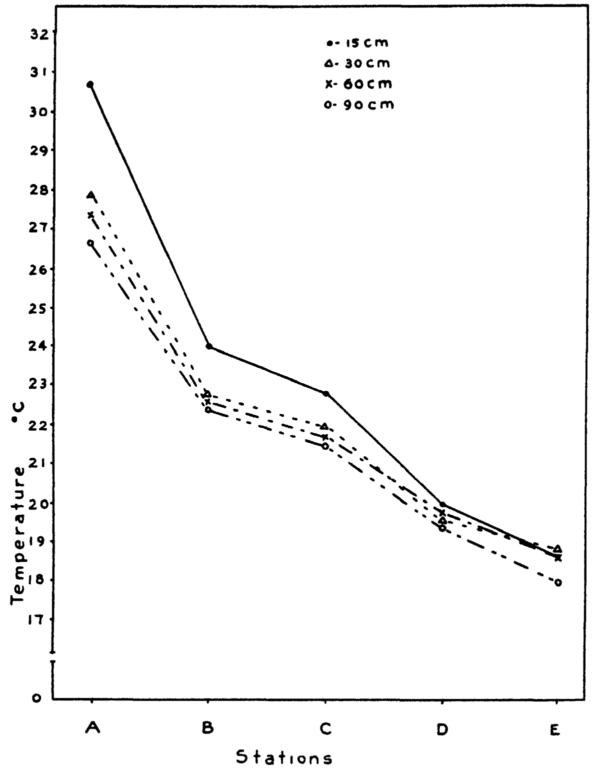

Figure 4.—Average soil temperature in degrees centigrade at 15 to 90 cm. depths at different stations recorded in 1933.

at Stations A, B, C, D, and E on March 19, 26, April 2, 9, 16, July 2, 9, 16, 23, 30, November 5, 12, 19, and 26, during 1933. In taking the soil samples, the area was first cleared of leaves and branches; then the soil auger was screwed in vertically to a depth of 90 cm., taking samples at 0-15, 30, 60, and 90 cm. The soil was placed in air-tight cans and brought back to the laboratory, weighed, placed in the oven for 40 hours at 105 to 110 degrees centigrade, then re-

weighed and the percent of soil moisture was calculated on dry weight basis by using the formula:

$$\text{Percent moisture} = \frac{\text{loss of weight}}{\text{weight of dried sample}} \times 100$$

The average percentage of soil moisture of all depths from 0 to 90 cm. at Station A was 27.10, at Station B, 45.19, at Station C, 58.94, at Station D, 84.93, and at Station E, 125.79 percent. At Station A, the soil moisture increased from 22.44 percent at 0-15 cm. depth to 31.30 percent at 90 cm. depth, an increase of 8.86 percent. At Station B the soil moisture increased from 39.31 percent at 0-15 cm. depth to 47.09 percent at 60 cm. depth and then dropped to 43.81 percent at 90 cm. depth, an increase of 7.78 percent and a decrease of 3.28 percent. At Station C, the soil moisture increased from 62.48 percent at 0-15 cm. depth to 66.73 percent at 30 cm. depth, and then dropped to 52.67 percent at 90 cm. depth, an increase of 4.25 percent and a decrease of 14.06 percent. At Station D, the soil moisture decreased from 110.00 percent at 0-15 cm. depth to 68.99 percent at 90 cm. depth, a decrease of 41.01 percent. At Station E, the soil moisture decreased from 209.64 percent at 0-15 cm. depth to 82.47 at 90 cm. depth, a decrease of 127.17 percent (fig. 5).

The soil moisture at Stations A and B increased with depth but the moisture at Stations C, D, and E decreased with increase in depth, with the exception of a slight rise in moisture at 30 cm. depth at Station C. The increase and decrease of soil moisture at Stations A, B, and C was slight, but the decrease of moisture at Station D and E was very great. The top layer of soil around Stations D and E constitute dead leaves and branches of plants that can absorb and retain more water than the soil below that contains less organic matter (table 4) and this accounts for the rapid decrease in moisture content from the top to the lower layers. The soil moisture of Kipapa Gulch increased with the increase in elevation.

Soil Acidity

To find out to what extent the soil acidity in Kipapa Gulch controls the distribution of plants, the hydrogen-ion concentration of the soils in the various plant zones was investigated. Soil samples at depths of 0-15, 30, 60, and 90 cm. were collected with a soil auger in Haole Koa, Guava, Koa, Ohia and the Cloud Zones (fig. 1) on

March 19 and 26, 1933. The samples were brought back to the laboratory in air-tight cans and were tested by the Hellige Colorimeter test. The soil acidity ranged from pH 7.0 to pH 4.0 in the different zones at various depths. Attempts to correlate these different acidities with the plant distribution were unsuccessful. A further detailed investigation of the hydrogen-ion concentration of the soil might reveal a relationship between plant associations and soil acidity.

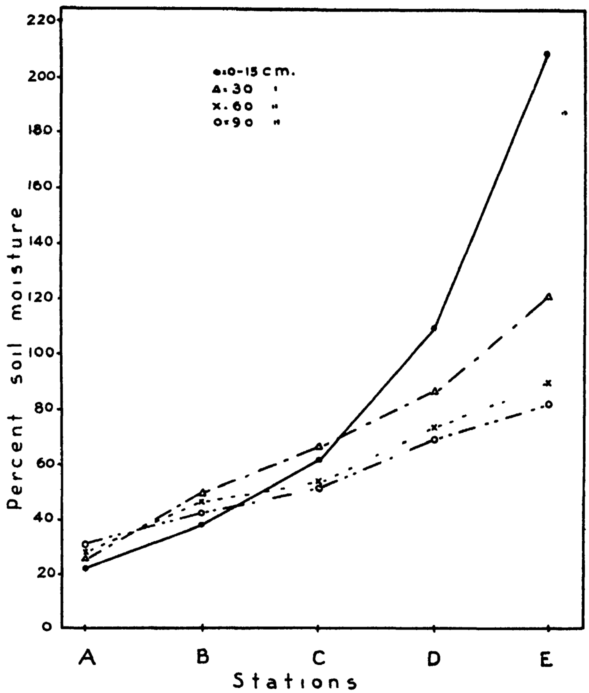

FIGURE 5.—Average percentage of soil moisture of samples collected at depths of 0-15, 30, 60, and 90 cm. on selected days during 1933 at Stations A to E.

ORGANIC CONTENT OF SOIL

The organic content of the soil was determined by the wet combustion method (38) and the samples used for this analysis were those collected for soil moisture determination. One hundred samples were analyzed. The samples were oven-dried for 40 hours at 105 to 110 degrees centigrade and in each case a 3-gram sample was used

for the organic content determination. The total percentages of organic matter found in the samples from 0 to 90 cm. depths at the various stations show that Station D has the highest organic content with 16.59 percent, Stations B, C and E comparatively equal amounts with 10.85 percent, 10.89 percent, 11.48 percent, respectively, and Station A the lowest with 2.75 percent (table 4). Station D is in the moist, wooded native forest where the ground is covered with dead plant products while Station A is in the dry, poorly vegetated region. The amount of organic content of the soil decreased with depth at every station investigated with the exception of Station A. The average percentages of the different depths of all the stations show that the greatest amount of organic matter is found in the first 15 cm. of soil.

Table 4. Average percentage of organic matter of five-soil samples taken at Stations A to E at depth from 0-90 centimeters.

Depth	Stations A	B	C	D	E
0-15 cm.	0.77	3.63	5.09	9.85	7.95
30 "	0.68	3.16	3.15	4.51	1.46
60 "	0.61	2.47	1.39	1.35	1.23
90 "	0.69	1.59	1.26	0.88	0.84
Total	2.75	10.85	10.89	16.59	11.48

VEGETATION

Phenology

Observations indicate that many native species have definite flowering periods and that in some months there are more plants in flower than in others. In order to obtain a statistical statement on flowering periods, a phenological record was kept as shown in the species record under Taxonomy (p. 211). The data cover three years of observation, during which time about 90 field trips were made into the native forest. July has the greatest number of plants in flower with 70 species, and December the least with 14 species (fig. 6). The number of plants in flower increases sharply from January with a slight drop in March to the maximum in July, and then drops sharply to December. July has the greatest number of plants in fruit with 52 species; January has the least with 6 species. Data for all

the species found in the region were not recorded on a single trip since not all of the species were seen in the course of a day's observation; but most of the species were observed during the three or four trips made in a month. In the native forest of Kipapa Gulch there are two groups of species of flowering plants, those with long and those with short periods of flowering.

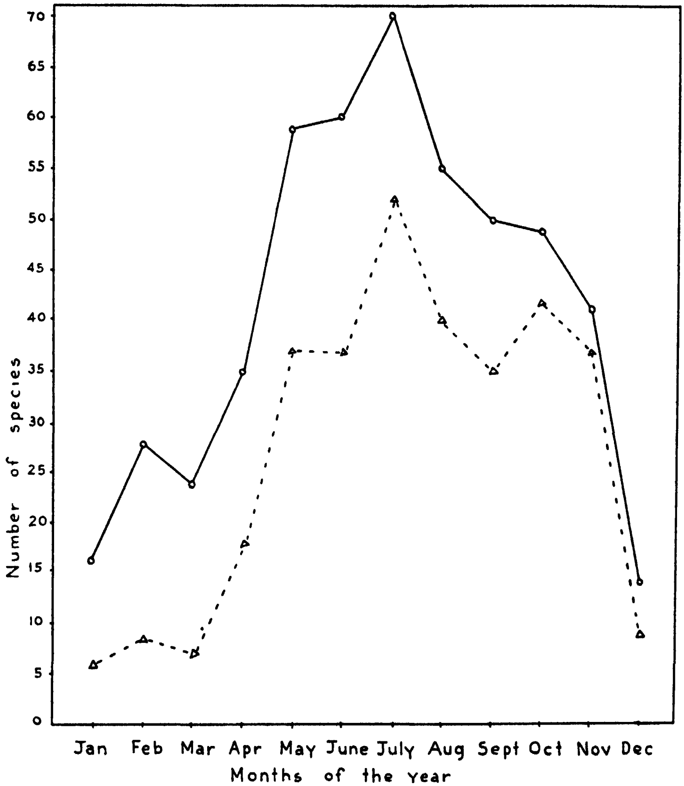

FIGURE 6.—Number of native species in flower and fruit throughout the year.

Some of those with an extended flowering season are *Phyllostegia glabra* variety *Macraei, Phyllostegia grandiflora, Scaevola Gaudichaudiana, Lantana Camara, Ilex anomala, Aleurites moluccana,* and *Psidium Guayava.* These species are found in flower during most of the months of the year.

Some of the short season indigenous species found in the native forest are *Rollandia angustifolia, Hesperomannia arborescens, La-*

bordia glabra, Labordia Cyrtandrae, Gardenia Remyi, Cheirodendron platyphyllum, Dubautia plantaginea, Lobelia oahuensis, Boehmeria grandis, and *Cordyline fruticosa.* During the three years of observation, these species were seen in bloom at about the same time each year.

Leaf Sizes

Leaf size varies within certain limits in plants of the same species and varies between different species, but in general, plants with large leaves are more numerous in the rain forests of the tropical regions.

In working out the leaf-size classes of Kipapa Gulch, Raunkiaer's system (43) was followed.

His classes are:

Class 1—Leptophylls up to 25 sq. mm.

Class 2—Nanophylls up to 225 sq. mm.

Class 3—Microphylls up to 2,025 sq. mm.

Class 4—Mesophylls up to 18,225 sq. mm.

Class 5—Macrophylls up to 164,025 sq. mm.

Class 6—Megaphylls larger than Class 5.

To get an idea of the number of leaf-size classes found in Kipapa Gulch, many leaves of each species were examined and the average recorded. In taking the measurement for the leaf-size classes, the entire compound leaf was considered as a unit. The author is in agreement with Withrow (67), who claims that "Parallel results are not obtained when the lobe of a leaf of one plant is measured, the leaflet of a second and the entire leaf of a third, since a part of one leaf is not comparable to another leaf in its entirety in dealing with area limits. However, by measuring the whole leaf in all cases comparable classification results."

In Kipapa Gulch are found all the leaf-size classes of Raunkiaer but most of the plants fall in Classes 3 and 4 and least in Class 6. Each plant zone (fig. 1 and p. 201, Plant Zones) was studied and the number of the various leaf-size classes of the higher flora including both indigenous and introduced species in each is shown in table 5.

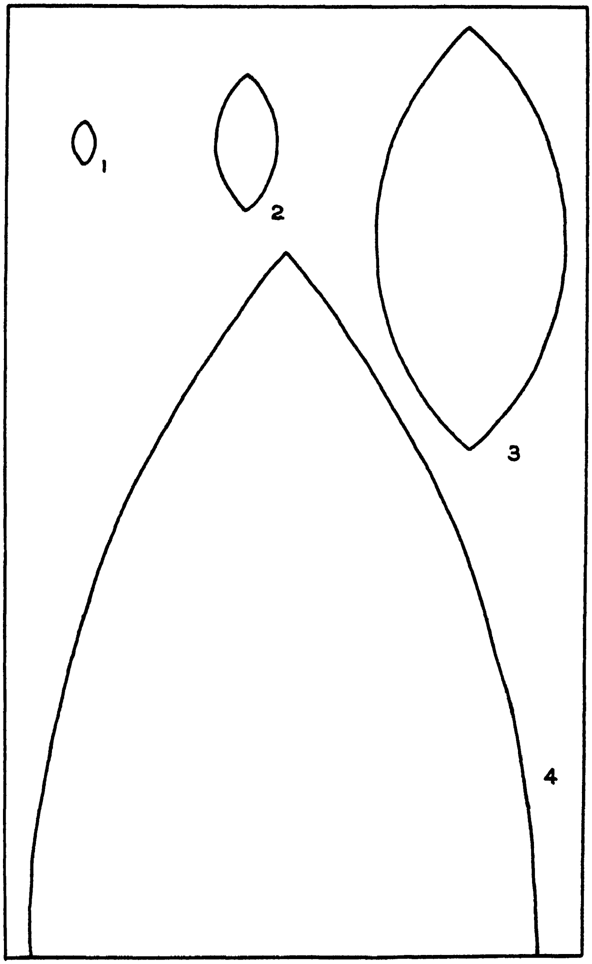

FIGURE 7.—Graphical representation of limits between leaf-size classes, after Raunkiaer: less than 1=leptophyll; between 1 and 2=nanophyll; between 2 and 3=microphyll; between 3 and 2x4=mesophyll; between 2x4 and 8x the size of diagram as bounded by black line=macrophyll; more than 8x the size of diagram as bounded by black line=megaphyll.

Table 5. Leaf-size classes of indigenous and introduced species of the various vegetational zones; data for introduced species in parentheses.

Zones	Leaf-Size Classes					
	1	2	3	4	5	6
Maritime No. of species	1 (4)	2 (7)	3(16)	1 (5)	— (1)	— (1)
Haole Koa No. of species	— (3)	3(17)	10(33)	4(12)	1(—)	— (1)
Guava No. of species	3 (4)	3(19)	16(37)	3(14)	3 (3)	— (2)
Koa No. of species	5 (1)	2 (3)	21(11)	20(11)	3 (4)	2 (1)
Ohia No. of species	15 (1)	8 (3)	62 (8)	113(13)	25 (4)	5 (2)
Cloud No. of species	9(—)	7 (2)	47 (4)	76 (4)	16(—)	4(—)

Considering only the indigenous species, there is a small number of species in the larger leaf-size classes and a large number in the smaller leaf-size classes in the Maritime, Haole Koa, and Guava Zones. In the Koa Zone there is about an equal number of species in the smaller and the larger leaf-size classes, but in the Ohia and Cloud Zones, there is a greater number of species in the larger leaf-size classes than the smaller leaf-size classes.

The above data indicate that with an increase in mesophytism there is an increase in the representatives of the large leaf-size classes. In Kipapa Gulch, the Ohia Zone has the largest number of 3, 4, 5, and 6 leaf-size classes.

Life Forms

The life forms of all the naturalized and indigenous vascular plants growing in Kipapa Gulch were recorded to determine the biological characteristics of the various vegetational zones. The life

form of the species is given in the Taxonomy section of this paper in reference to the system of Raunkiaer (43) as follows:

(E) epiphytes

(MM) mega- and meso-phanerophytes, with dormant parts more than 8 meters above the ground.

(M) microphanerophytes, with dormant parts 2 to 8 meters above the ground.

(N) nanophanerophytes, with dormant parts 0.5 to 2 meters above the ground.

(Ch) chamaephytes, with dormant parts not over 25 to 30 cm. above the surface of the ground.

(H) hemicryptophytes, with dormant parts in the soil surface.

(G) geophytes, with dormant parts below the ground.

(HH) helophytes, with dormant parts in water-saturated ground.

(HH) hydrophytes, with dormant parts at the bottom of bodies of water.

(Th) therophytes (annuals).

In Hawaii the temperature conditions are favorable continuously throughout the year with moisture conditions locally and seasonally unfavorable. Hence most of the plants lack well insulated buds or other resting organs that are found on plants in colder regions. Actually most of the plants grow throughout the year, or with but brief interruptions. The position of the growing points has been used in the attempt to apply the Raunkiaer system to the flora. The life form spectra of the plants found in the different zones of Kipapa Gulch are given in table 6. In the table are given the total number of the species of higher flora recorded for the zones and the number of species in each life form.

Table 6. Life forms of indigenous species of Pteridophytes and Spermatophytes found in the different vegetational zones of Kipapa Gulch; data for introduced species in parentheses.

Zones	Life Form Classes								
	MM	M	N	Ch	H	G	HH	Th	E
Maritime No. of species	-(2)	-(-)	2(9)	4(1)	1(10)	-(1)	-(6)	-(5)	-(-)
Haole Koa No. of species	-(3)	2(5)	7(29)	-(4)	6(11)	-(-)	-(-)	2(16)	-(-)
Guava No. of species	-(6)	5(5)	8(26)	1(5)	9(16)	-(1)	-(1)	1(19)	1(-)
Koa No. of species	12(5)	14(5)	13(6)	2(2)	8(5)	-(3)	-(1)	-(4)	2(-)
Ohia No. of species	28(5)	68(5)	47(3)	6(2)	40(9)	-(3)	-(1)	-(2)	23(-)
Cloud No. of species	15(-)	50(2)	30(2)	5(1)	27(3)	-(-)	-(-)	-(2)	17(-)

The ground surface and the moss-covered tree trunks serve as habitats for several species. The following plants with two life forms are not considered in table 6.

Trichomanes Baldwinii
Trichomanes cyrtotheca
Trichomanes davallioides
Asplenium obtusatum
Asplenium monanthes
Elaphoglossum gorgoneum
Lindsaya Macraena
Polypodium tamariscinum
Lycopodium nutans
Lycopodium phyllanthum
Lycopodium serratum
Lycopodium serratum var. dentatum
Psilotum complanatum
Psilotum nudum
Selaginella Menziesii
Astelia veratroides
Anoectochilus sandwicensis
Peperomia elliptibacca
Peperomia latifolia
Peperomia oahuensis
Peperomia reflexa

The spectrum of the maritime flora shows that small herbs, shrubs, and hydrophytes are the common plants of the region with nanophanerophytes comprising about half the species. In the Haole Koa Zone, the shrubs are the important plants, constituting over half the species. The Guava Zone shows a similar spectrum. The Koa Zone shows that larger trees are becoming common, but the shrubs are still the most abundant plants. In the Ohia Zone the tall trees constitute quite a large percentage of the species. Table 6 shows a large number of mega- and mesophanerophytes and micro-phanerophytes in the Cloud Zone but there the species are stunted to about half their normal size.

Table 7. Life form in percent of indigenous species of flowering plants found in Kipapa Gulch compared with the normal spectrum of Raunkiaer (42) and the spectrum of St. Thomas and St. John, Virgin Islands (41).

	Life Form Classes								
	No. of species	MM	M	N	Ch	H	G	HH	T
St. Thomas and St. John	904	5	25	30	12	9	3	1	14
Kipapa Gulch	206	15	39	28	6	12	—	—	1
Normal spectrum	1,000	8	18	15	9	26	4	2	13

The spectrum of the flowering plants of Kipapa Gulch (table 7) shows that microphanerophytes have the largest percentage with nanophanerophytes a close second and mesophanerophytes third. The tall trees, though not many with respect to percentage, constitute a dominant part of the vegetation, especially in the Ohia Zone.

The spectrum of Kipapa Gulch is very similar to that of St. Thomas and St. John of the Virgin Islands. Both are typical of tropical regions in possessing a relatively high percentage of phanerophytes as compared to Raunkiaer's normal spectrum.

Transect Studies

To determine the zonation, stratification, and the composition of the vegetation in Kipapa Gulch, transect lines were surveyed at the Haole Koa, Guava, Koa, Ohia, and Cloud Zones. In every case the survey was made across the gulch from the south to the north ridge (fig. 1). In recording the species, any plant that touched, crossed

over or below the tape was recorded. Transect I in the Haole Koa Zone recorded 17 species, none endemic, 3 indigenous, and 14 introduced; transect II in the Guava Zone registered 37 species, 5 endemic, 7 indigenous, and 25 introduced; transect III in the Koa Zone recorded 43 species, 17 endemic, 12 indigenous, and 14 introduced; transect IV in the Ohia Zone recorded 102 species, 69 endemic, 16 indigenous, and 17 introduced; transect V in the Cloud Zone registered 57 species, 43 endemic, 8 indigenous, and 6 introduced.

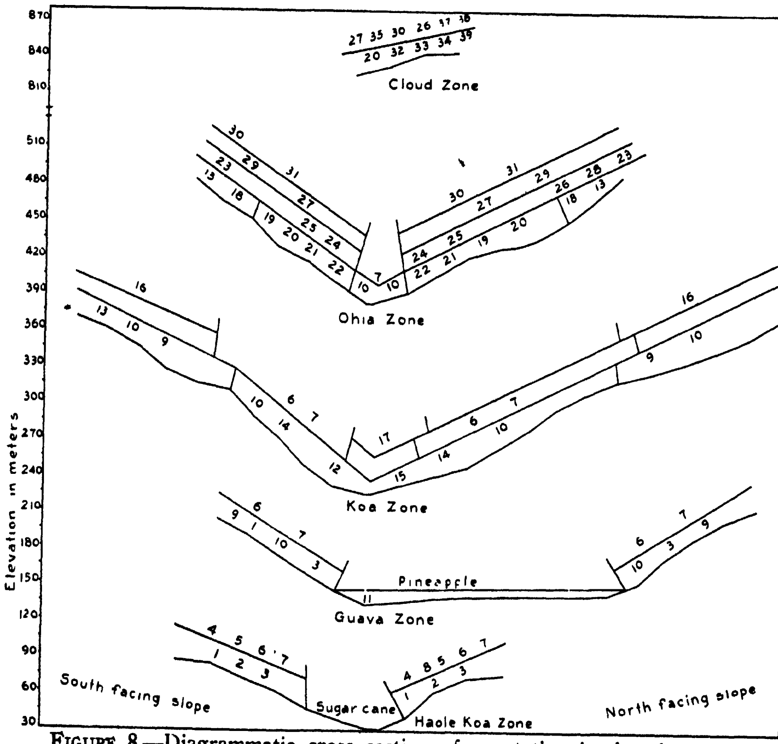

FIGURE 8.—Diagrammatic cross section of vegetation in the plant zones: vertical scale, 6 mm.=15 m.; horizontal scale, 12 mm.=30 m. 1, *H. contortus*; 2, *T. repens*; 3, *C. aciculatus*; 4, *O. megacantha*; 5, *A. Farnesiana*; 6, *L. Camara*; 7, *P. Guayava*; 8, *L. glauca*; 9, *S. chinensis*; 10, *P. orbiculare*; 11, *P. purpurascens*; 12, *C. diffusa*; 13. *G. linearis*; 14, *N. exaltata*; 15, *O. hirtellus*; 16, *A. Koa*; 17, *A. moluccana*; 18, *P. grandiflora*; 19, *Trichomanes*; 20, *mosses*; 21, *Polypodium*; 22, *Elaphoglossum*; 23, *F. arborea*; 24, *Cyrtandra*; 25, *Gouldia*; 26, *Labordia*; 27, *B. elatior*; 28, *P. sandwicensis*; 29, *Straussia*; 30, *Metrosideros*; 31, *E. sandwicensis*; 32, *P. conjugatum*; 33, *P. koolauense*; 34, *P. pachyphylla*; 35, *Pelea*; 36, *Labordia*; 37, *Dubautia*; 38, *E. Martii*; 39, *M. angustifolius*.

The transect studies show that there is quite a definite plant zonation, stratification, and composition in Kipapa Gulch. Figure 8 is a diagrammatic presentation of the vegetation of the gulch in cross-section. Here only the most characteristic species of the respective layers are given.

The most complex vegetation is found in the Ohia Zone. A detailed description of the different zones is given on pp. 201-7.

Frequency and Cover Degree Studies

In order to obtain a definite basis for the subdivision of the vegetation of Kipapa Gulch into zones, quantitative studies were undertaken. This was by the established method of cover degree and frequency readings. Areas were selected at random; then each plot was approximately measured off into quadrats four meters square. After a census, records were made of the number and the amount of vertical ground coverage of each species in the plot, and from these the frequency and cover degree were calculated. The cover degree of each species found growing in the area was recorded according to the system of Braun-Blanquet (6). His cover degree scale is as follows:

I = very scant (covering less than 1/20 of the ground surface)
II = covering 1/20 to 1/4 of the ground surface
III = covering 1/4 to 1/2 of the ground surface
IV = covering 1/2 to 3/4 of the ground surface
V = covering 3/4 to 4/4 of the ground surface

Frequency is expressed on the basis of the five classes of Raunkiaer (43):

Class A = species found in 1-20% of the quadrats
Class B = species found in 21-40% of the quadrats
Class C = species found in 41-60% of the quadrats
Class D = species found in 61-80% of the quadrats
Class E = species found in 81-100% of the quadrats

The readings were made in groups of ten plots, each four meters square. The percentage of frequency of a given species is the percentage ratio which the number of plots on which the species occurs bears to the whole number of plots taken. Raunkiaer points out that, as we proceed to the greater frequencies, the number declines steadily, then, as the highest frequence is reached, increases slightly.

That is, the curve expressing numbers of the different frequencies has two peaks, a high one expressing the least frequence, and another, considerably lower, expressing the greatest frequence. He interprets the law as signifying that, in an association at a state of relative equilibrium, one or several species prosper at the expense of other species growing near by, because the dominant species are better situated to live and develop in the conditions presented to the formations of which they compose part, and by life competition hinder the other species from equaling them. The plant communities in the zones were quite homogeneous (fig. 9).

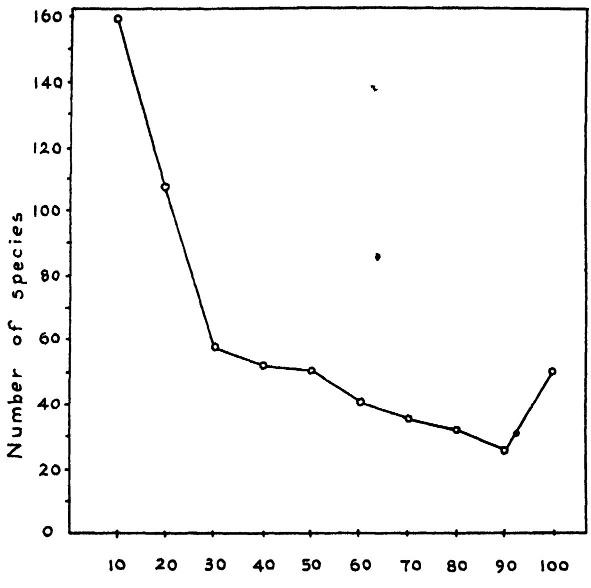

FIGURE 9.—Frequency curve of vegetation in the Ohia Zone.

The cover degree and frequency in percent of the characteristic species in the various vegetational zones are as follows:

In the Maritime Zone, *Batis maritima* had a cover degree of III and a frequency of 70; *Sesuvium Portulacastrum*, III and 75; *Scirpus maritimus*, IV and 53. In the Haole Koa Zone, *Acacia Farnesiana* had a cover degree of III and a frequency of 75; *Heteropogon contortus*, III and 84; *Opuntia megacantha*, III and 65. In the Guava Zone, *Psidium Guayava* had a cover degree of IV and a frequency of 85; *Lantana Camara*, III and 75; *Chrysopogon aciculatus*, III and 50; *Paspalum orbiculare*, III and 60. In the Koa Zone, *Acacia*

Koa had a cover degree of IV and a frequency of 40; *Gleichenia linearis*, IV and 70; *Aleurites moluccana*, III and 30. In the Ohia Zone, *Metrosideros collina* had a cover degree of V and a frequency of 90; *Gleichenia linearis*, III and 60. In the Cloud Zone, *Paspalum conjugatum* had a cover degree of III and a frequency of 40; *Metrosideros collina*, II and 60. The cover degree and frequency of other species found in the different vegetational zones varied from I to II for cover degree and 10 to 70 for frequency.

Maritime Zone

The vegetation of the Maritime Zone, which is poorly represented in the area studied, is influenced mainly by local edaphic conditions that occur adjacent to the beach. The vegetation of this zone is characterized by the *Batis-Scirpus* Community. *Batis maritima* makes a thick stand along the shore of the loch. It is also found growing among patches of *Scirpus maritimus* above the high tide level. *Scirpus maritimus* is conspicuous since it overtops the other species in the area. In drier places *Scirpus laevigatus* is found in patches of 0.5 to 2 meters across and between these is a mat of *Sesuvium Portulacastrum*. On higher places where the soil is dry, *Prosopis chilensis, Panicum purpurascens* and *Pluchea indica* are conspicuous. *Panicum purpurascens* makes a solid growth along the banks of the stream. In the stream where the current is slow, *Potamogeton foliosus* variety *macellus, Lemna minor* and *Spirodela polyrhiza* are found in large numbers.

Haole Koa Zone

The vegetation of this region is predominantly xerophytic. *Opuntia megacantha* forms clumps 1.5 to 3 meters high and from 1 to 5 meters in diameter on the dry rocky hillsides. These are very conspicuous and they give the xerophytic appearance to the landscape (fig. 10). *Acacia Farnesiana, Heteropogon contortus, Lantana Camara, Psidium Guayava, Cassia Leschenaultiana* and *Stachytarpheta jamaicensis* are found filling the spaces between the clumps of *Opuntia megacantha.*

Acacia Farnesiana is a low, much branched shrub 0.5 to 1.5 meters tall, with few leaves at the ends of the branches. *Heteropogon contortus* grows in the open and under bushes, and during the drier months gives a straw-color to the hillsides. *Lantana Camara* and *Psidium Guayava* are low half-dried shrubs 1 to 2 meters tall. In sheltered gullies where there is greater moisture, *Psidium Guayava* becomes slightly taller. At several places in sheltered gullies *Leu-*

caena glauca plants have developed and are quite conspicuous. On eroded places *Waltheria indica* variety *americana* is common and this species seems to prefer such areas. At the upper end of the zone there are a few individual clumps of *Dodonaea viscosa* 1 to 2 meters tall and 1 to 1.5 meters across. The vegetation of this zone is quite uniform, due to the dominance of the four common species; it may be classified as an *Opuntia-Acacia-Heteropogon-Leucaena* Community.

FIGURE 10—*Opuntia megacantha, Acacia Farnesiana,* and *Heteropogon contortus* in the Haole Koa Zone

GUAVA ZONE

The vegetation of this region is characterized by the uniform cover of *Psidium Guayava* and *Lantana Camara* which are found in mixtures and in pure stands. Those that occupy the steep slopes are scrubby and smaller than those growing along the stream bank and in sheltered bottoms of side gullies. This difference in height is more noticeable with *Psidium Guayava.* The *Psidium* trees growing along the stream bank and in more favorable places attain an average height of 4 to 6 meters. The *Lantana* bushes usually make an entanglement under the *Psidium Guayava* and make it very dif-

ficult to pass through such places. Along the stream bank and on areas just back of it, *Commelina diffusa, Paspalum conjugatum,* and *Panicum purpurascens* are found forming the undergrowth in mixtures and in pure stands. On the more open, exposed slopes *Paspalum orbiculare, Chrysopogon aciculatus, Heteropogon contortus* and *Stenoloma chinesis* are common. In the bottoms of some of the side gullies, one to five *Aleurites moluccana* trees 4.5 to 8 meters tall are found. At the upper ends of such gullies large *Acacia Koa* trees 5 to 10 meters in height are found forming solid stands. Probably these stands are the remnants of former large stands. The vegetation of this area can be considered to be a *Psidium-Lantana* Community because of the dominance and distribution of these two species.

FIGURE 11.—Vegetation of the Koa Zone showing *Acacia Koa* on the upper slope and *Aleurites moluccana* in the gully bottom.

KOA ZONE

The most characteristic features of this zone are the presence of pure stands of *Acacia Koa, Aleurites moluccana* and *Gleichenia linearis.* The *Acacia Koa* and *Gleichenia linearis* occupy the slopes and ridges, while *Aleurites moluccana* occupies the bottom of the gulch and side gullies (fig. 11). The *Acacia Koa* attains a height of about 12 meters and a diameter of 0.5 to 1 meter or more, and is found in groves or solitary. *Aleurites moluccana* grows straight up into trees 15 meters tall and forms patches in the bottoms of the gulch and gullies. The light colored foliage of this species is very con-

spicuous. *Eugenia malaccensis* is the most common associate of *Aleurites moluccana.* On the open slopes *Gleichenia linearis* makes a dense covering. In areas where the *Gleichenia* fern has not spread, *Cordyline fruticosa* and *Psidium Guayava* are the common species. Under the tall trees, where the ground is moist, *Oplismenus hirtellus, Zingiber Zerumbet, Marattia Douglasii, Dryopteris cyatheoides,* and

FIGURE 12.—Undergrowth vegetation of a side gully in the lower Ohia Zone showing *Nephrolepis exaltata* in the foreground and *Asplenium nidus* growing on the trunks of *Aleurites moluccana.*

Cibotium Chamissoi are common. Under the *Psidium Guayava* shrubs, *Paspalum conjugatum* and *Nephrolepis exaltata* are very common.

OHIA ZONE

The vegetation of this area is predominantly mesophytic with *Metrosideros collina* as the dominant and most characteristic species.

This species is found in large numbers throughout the area but attains its maximum height at 550 meters elevation. Four strata vegetation is found in this zone (figs. 12, 13). Other dominant species are *Bobea elatior* and *Eugenia sandwicensis*; the third layer species include *Elaeocarpus bifidus, Antidesma platyphyllum, Pittosporum glabrum* and *Straussia Mariniana*; the second layer species are

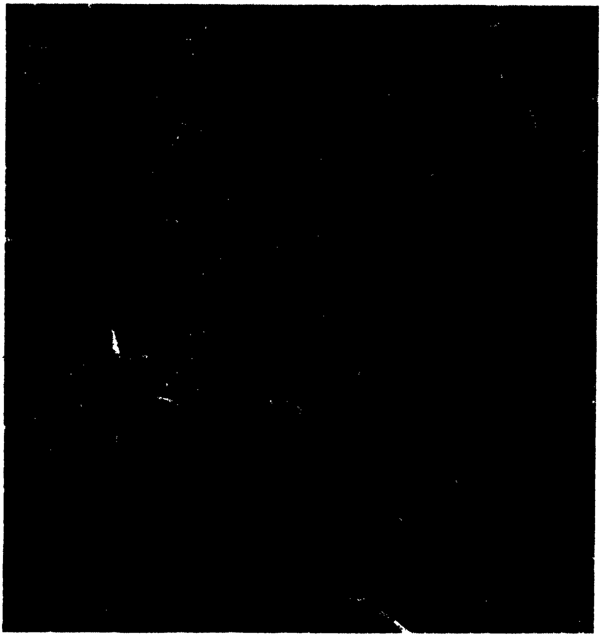

FIGURE 13.—Undergrowth vegetation of the upper Ohia Zone near the ridge showing *Cibotium Menziesii* in left center and *Freycinetia arborea* climbing on tree.

Cyrtandra plaudosa, Phyllostegia grandiflora, Rollandia crispa, Touchardia latifolia and *Cibotium Chamissoi*; the lower layer is composed of mosses, *Trichomanes* spp., *Blechnum occidentalis,* and *Peperomia* spp. The tree trunks are covered with epiphytic plants as *Polypodium pseudo-grammitis, Polypodium lineare, Hymenophyllum recurvum, Astellia veratroides,* and mosses. This vegetation can be called the *Metrosideros collina* Community from the abundance and dominance of this species.

Cloud Zone

Above 600 meters the region is in the cloud area, and an open low scrubby moss-covered vegetation is found. The trees on the slopes and ridges are dwarfed (to about 1 to 2.5 meters in height) and the few tall trees (not more than 6 meters in height) of this zone are found in the gullies (fig. 14). There is no dominant species in the

Figure 14.—Vegetation of the lower Cloud Zone showing poor growth of plants due to effect of fog and cloud.

zone and the conspicuous species are quite uniformly distributed. Some of the more conspicuous plants are *Eupritchardia Martii, Cheirodendron platyphyllum, Metrosideros collina, Bobea elatior, Straussia kaduana, Fagara oahuensis, Labordia glabra* and *Labordia fagraeoides* (fig. 15). In this zone four layers of vegetation are found only at the few places where the scattered tall trees are found. A poorly developed three layer spectrum is found throughout the area except at the crest of the summit ridge where the wind blows unceasingly. Here only two layers of vegetation are found. Some of the plants are *Peperomia ellipticibacca, Phyllostegia lantanoides, Panicum*

koolauense, Dubautia laxa, Isachne pallens, Mariscus angustifolius, and *Paspalum conjugatum.*

North and South Facing Slopes

At elevations above 152 meters in the Guava Zone, there is a difference of vegetation between the north and the south facing slopes. On the north facing slope is found a larger number of native species that are associated with the forest vegetation, such as *Metrosideros collina, Pipturus albidus, Dianella sandwicensis, Scaevola Gaudichaudiana, Wikstroemia oahuensis* and *Santalum Freycinetianum,* while on the south facing slope there are only a few or none of these species.

Data on soil temperature, soil moisture, and evaporation were recorded approximately at 4:00 p.m. on the north and south facing slopes at 220 meters elevation on different days in May, June and October, 1933. Soil temperature at 15, 30, and 60 cm. depths were recorded, and the average of all the depths of the six readings of the north facing slope was 24.0 degrees centigrade and that of the south facing slope 26.0 degrees centigrade, a difference of 2 degrees centigrade. The greatest difference in temperature was found in the 15 cm. depth.

Readings from Livingston white bulb atmometers set up in the open show greater evaporation on the south facing slope, with the average evaporation for the five readings at intervals of seven days on the north facing slope as 217.79 cc., and the south facing slope as 257.00 cc., a difference of 39.21 cc.

The average soil moisture content of the north facing slope was higher than that of the opposite slope with the greatest difference in the first 15 cm. of soil. The average soil moisture of 15 to 60 cm. depths on the north facing slope was 38.21 percent while that of the south facing slope was 30.42 percent, a difference of 7.79 percent. At 15 cm. depth there was 35.94 percent moisture on the north slope and 26.03 percent on the south slope with a difference of 9.91 percent; at 30 cm. depth, 37.86 percent on the north facing slope and 28.69 percent on the south facing slope; at 60 cm. depth, 40.84 percent on the north slope and 36.55 percent on the south slope.

The differences in soil temperature, soil moisture and evaporation show that the north facing slope is more favorable for plant growth

than the south facing slope and probably explains the development of forest species. Bates (3) and Cannon (9) found that soil temperature at the soil surface determines the life-and-death struggle of young seedlings and plant distribution. It seems that a difference of 2.2 degrees centigrade in temperature, 39.21 cc. in evaporation and 9.91 percent in soil moisture in the region where seedlings develop, affect the type of vegetation of the slopes.

In the Koa, Ohia and Cloud Zones, it seems that the factors are

FIGURE 15.—Vegetation in the Cloud Zone showing *Eupritchardia Martii, Mariscus angustifolius, Isachne pallens,* and *Paspalum conjugatum.*

not sufficiently different on the two slopes to cause any difference in the vegetation as in the Guava Zone. That is, any difference in the environmental factors lies within the range of the tolerance of this species. In the Haole Koa Zone there is practically no difference in the vegetation of the two slopes.

Successional Relations

In the Maritime Zone along the shore, *Batis maritima* and *Scirpus maritimus* will probably hold their own against the invasion of other

species under the present conditions. On the dry places, *Prosopis chilensis* will undoubtedly become the dominant species with *Panicum purpurascens* as undergrowth if such places are left undisturbed for natural development.

The vegetation of the Haole Koa Zone seems to be changing. *Leucaena glauca* grows into a taller plant than *Psidium Guayava, Lantana Camara,* and *Acacia Farnesiana* with which it is associated,

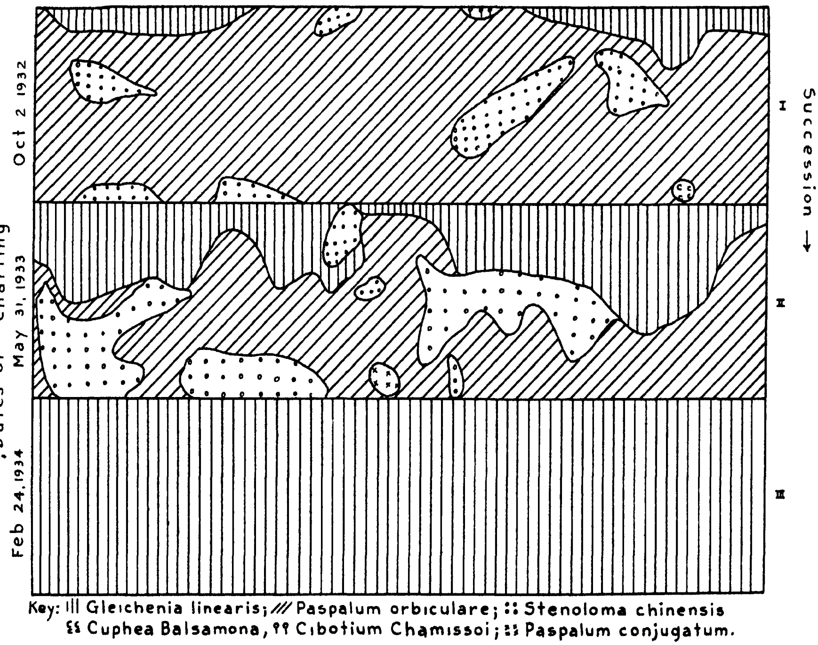

FIGURE 16.—Quadrat 1 x 4 meters at 380 meters elevation showing spread of *Gleichenia linearis.*

and is gradually crowding and shading them out. It also produces a much larger crop of seeds than the associated species.

The vegetation of the Guava Zone can be considered reasonably stable under the present conditions. The quadrat studies point out a well balanced relationship between *Psidium Guayava* and *Lantana Camara* of the upper layer with *Chrysopogon aciculatus* and *Paspalum orbiculare* of the ground layer.

In the Koa Zone, the most active plant succession is taking place. The *Acacia Koa* is coming back into the abandoned pineapple fields

at many places. *Acacia* and *Metrosideros* were abundant before the cultivation of pineapple. Abandoned fields at the bottom of the gulch are revegetated principally with *Psidium Guayava, Lantana Camara, Panicum purpurascens* and *Erigeron albidus* during the earlier stages of succession, but gradually *Psidium Guayava* becomes the dominant species. Along the upper margin of the abandoned pineapple fields, close to the native forest, *Gleichenia linearis* is coming in and spreading at an average rate of 90 cm. a year (figs. 16, 17). The present condition indicates a dominance of *Gleichenia* throughout the Koa Zone in the future.

FIGURE 17.—Recording the succession of *Gleichenia linearis* in the Koa Zone.

The vegetation of the Ohia Zone is quite stable. The greatest undergrowth competitor is *Gleichenia linearis* and the ground vegetation of ferns may be crowded out slowly by *Gleichenia*; but the physiognomy of the vegetation will probably not change unless the *Metrosideros* is destroyed by fire or disease. At several open places along the stream bank, *Paspalum conjugatum* is coming in to replace the ferns and other low native plants.

In the Cloud Zone the pigs are destroying the plants and the vegetation is unstable. At several places, whole hillsides have been denuded of vegetation and the destructive work of erosion is taking

place. At other places the indigenous ferns and low species are uprooted and *Paspalum conjugatum* is taking possession. At places where bare grounds have been exposed by landslides, *Mariscus meyenii* and *Erechtites hieracifolia* come in first.

TAXONOMY

METHODS

The native, naturalized, and introduced plants in Kipapa Gulch were collected and identified. The specimens have been deposited in the herbarium of Bishop Museum. In working up the taxonomy of the plants found growing in Kipapa Gulch, Hillebrand (23), Rock (44-51), Skottsberg (56-58), Christensen (12), Hitchcock (24), Degener (16), Forbes (19), and works of many others were consulted for the valid names as far as they could be determined.

EXCLUDED PLANTS

In the valley, there are about fifty houses scattered from the Maritime to the Guava Zones and around these houses the people have planted ornamental herbs, shrubs, and trees, such as *Phyllanthus nivosus* (Snow bush), *Codiaeum variegatum* (Croton), *Casuarina equisetifolia* (Ironwood), *Cassia javanica* (Rainbow shower) and *Ficus indica* (Rubber tree). These cultivated species are not included in this study.

There are also the cultivated food plants, as *Carica papaya* (papaya), *Ipomoea batata* (sweet potato), *Brassica sativa* (cabbage) and the leading crops, *Ananas comosus* (pineapple) and *Saccharum officinarum* (sugar cane) that are also not included in this study. At about 120 meters elevation in the gulch, where it is too steep and rocky for cultivation, the Oahu Sugar Company has recently planted fast growing trees and these, too, are excluded.

ANALYSIS OF THE FLORA

The species are divided into three groups in reference to their occurrence in the Hawaiian islands: endemic, species peculiar to the islands; indigenous, species native to the islands; and introduced, those species brought into the islands from other regions. The geographical distribution of these introduced species is given. Many of the endemic and indigenous species found in Kipapa Gulch are widely

scattered throughout the Hawaiian islands, but there are several species peculiar to Oahu and a few restricted to the Koolau Range.

The occurrence of each species is given in reference to the number of localities at which the species were observed or collected as: abundant, at more than 34 localities; common, at 16 to 33 localities; occasional, at 7 to 15 localities; rare, at 3 to 6 localities; and very rare, at 1 to 2 localities. Often only a single specimen was observed at a place and at other times 2 to 10 or more plants of the same species were seen at a locality.

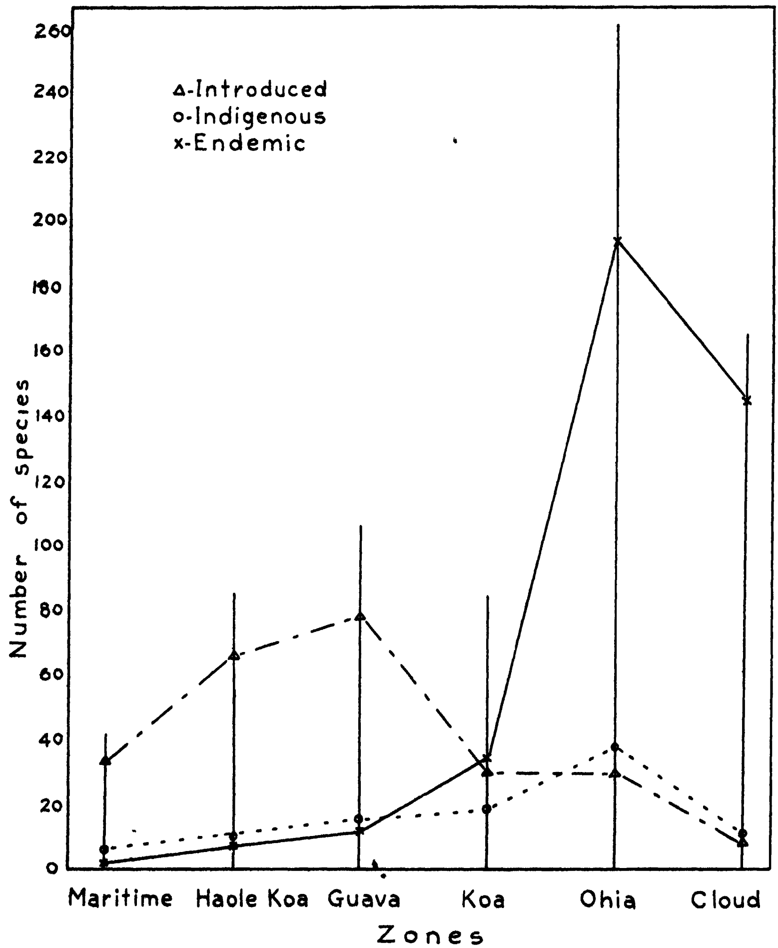

FIGURE 18.—Number of species of plants found in zones studied and number of endemic, indigenous, and introduced species in these zones.

The distribution of the species is recorded with reference to the six vegetational zones of Kipapa Gulch (fig. 18), and table 8.

Figure 18 shows that the largest number of endemic species are found in the Ohia and Cloud Zones; the largest number of indigenous species in the Ohia Zone, and the largest number of introduced species in the Guava and Haole Koa Zones.

Table 8. The floristic composition of Kipapa Gulch.

Plants	No. of Species	Percent
Musci	34	7.6
Pteridophyta	75	16.7
Angiospermae	340	75.7
Total	449	

Table 8 shows that the flowering plants make up 75.7 percent of the flora; ferns and fern allies, 16.7 percent; and the mosses, 7.6 percent. The Musci have not been as intensively collected as the Pteridophytes and Angiosperms.

Table 9. Status of the plants of Kipapa Gulch.

	Mosses	Ferns and Fern Allies	Plants Flowering	Percent
Endemic	22	47	189	57.4
Indigenous	12	23	25	13.4
Introduced	0	5	126	29.2

Table 9 shows that over half of the species of plants considered in the investigation are endemic, less than a fourth indigenous and little over one fourth introduced. One species of moss was not counted because the specific name was not determined. Majority of introduced plants are very suggestive in lower elevations.

Abbreviations

A list of the native or naturalized plants found in Kipapa Gulch arranged by families, genera and species and tabulated according to occurrence, life form, leaf-size, abundance, distribution, and period of flowering are presented in the following pages. When the information of a species is not available, that part is omitted by a dash. In

the case of Bryophytes only the occurrence and distribution are given. The symbols used in this section are as follows:

I. Occurrence: E, endemic; I, indigenous; In., introduced.

II. Life form: E, epiphytes; MM, mega- and meso-phanerophytes; M, microphanerophytes; N, nanophanerophytes; Ch, chamaephytes; HH, hydrophytes; H, hemicryptophytes; G, geophytes; Th, therophytes.

III. Leaf size: 1, 2, 3, 4, 5, 6.

IV. Abundance: a, abundant; c, common; o, occasional; r, rare; vr, very rare.

V. Distribution (Zones): M, Maritime; H, Haole Koa; G, Guava; K, Koa; O, Ohia; C, Cloud.

VI. Phenology (Flowering Period): numbered according to month of year, January=I, etc.

	I	II	III	IV	V	VI
BRYOPHYTA						
Dicranaceae						
Campylopus densifolius Ångström	E				O	
C. umbeliatus (W. Arnott) Bartram	I				C	
Dicranella Hillebrandi (C. Müller) Brotherus	E				C	
D. integrifolia (Brotherus) Bartram	E				G	
Dicranodontium falcatum Brotherus	E				C	
Holomitrium seticalycinum C. Müller	E				O,C	
Leucoloma molle (C. Müller) Mitten	I				C	
L. scaberulum Bartram	E				O	
Leucobryaceae						
Leucobryum gracile Sullivant	E				C	
Funariaceae						
Funaria subintegra Brotherus	E				C	
Bryaceae						
Rhodobryum giganteum (Hooker) Schimper	I				C	
Rhizogoniaceae						
Rhizogonium pungens Sullivant	E				O	
R. spiniforme (Hedwig) Bruch	I				O,C	
Bartramiaceae						
Breutelia arundinifolia (Duby) Fleischer	I				C	
Philonotis sp.	—				O	
Orthotrichaceae						
Macromitrium brevisetum Mitten	E				O	
M. piliferum Schwaegrichen	E				O	
Rhacopilaceae						
Rhacopilum cuspidigerum (Schwaegrichen) Mitten	I				O	
Meteroriaceae						
Barbella trichophora (Montagne) Fleischer	E				O	
Neckeraceae						
Baldwinella kealeensis (Reichardt) Bartram	E				O	
Homaliodendron flabellatum (Dickson, Smith) Fleischer	I				O,C	

	I	II	III	IV	V	VI
Hookeriaceae						
Distichophyllum paradoxum (Montagne) Mitten	E				O	
Hookeria acutifolia Hooker	I				O	
Hookeriopsis purpurea (C. Müller) Brotherus variety ligulacea (C. Müller) Bartram	E				O	
Thuidiaceae						
Thuidium hawaiiense Reichardt	E				O,C	
Brachytheciaceae						
Brachythecium oxyrrhynchium (Dozy and Molkenboer) Jaeger	I				O	
Pleuropus Wilkesianus (Sullivant) Brotherus	E				O,C	
Sematophyllaceae						
Acroporium fusco-flavum (C. Müller) Brotherus	E				O,C	
Trichosteleum hamatum (Dozy and Molkenboer) Jaeger	I				O,C	
Hypnaceae						
Ctenidium decurrens (Sullivant) Brotherus	E				O	
Ectropothecium arcuatum (Sullivant) Mitten	E				O	
Isopterygium albescens (Schwaegrichen) Jaeger	I				O	
Vesicularia graminicolor (Ångström) Brotherus	E				O	
Polytrichaceae						
Pogonatum Baldwini (C. Müller) Paris	E				O	
Orthotrichaceae						
Macromitrium owahiense C. Müller	I				O	
PTERIDOPHYTA						
Hymenophyllaceae						
Hymenophyllum lanceolatum Hooker and Arnott	E	E	3	c	O,C	
H. obtusum Hooker and Arnott	E	E	2	c	O,C	
H. recurvum Gaudichaud	E	E	3	c	O,C	
Trichomanes Baldwinii (Eaton) Copeland	I	H,E	4	o	O,C	
T. cyrtotheca Hillebrand	E	H,E	4	o	O,C	
T. davallioides Gaudichaud	E	H,E	4	o	O,C	
T. parvulum Poiret	I	E	1	r	O	

	I	II	III	IV	V	VI
Cyatheaceae						
Cibotium Chamissoi Kaulfuss	E	N	6	a	K,O,C	
C. Menziesii Hooker	E	N	6	c	O,C	
Polypodiaceae						
Asplenium contiguum Kaulfuss	E	H	4	o	O,C	
A. horridum Kaulfuss	E	H	5	o	O,C	
A. obtusatum Forster	In	H,E	5	o	O	
A. monanthes Linnaeus	I	H,E	3	o	O	
A. nidus Linnaeus	I	E	5	o	O	
A. lobulatum Mettenius variety pseudofalcatum (Hillebrand) C. Christensen	E	H	4	o	O,C	
Athyrium microphyllum (Smith) Alston	E	H	5	c	O,C	
A. proliferum (Kaulfuss) C. Christensen	E	H	5	c	O,C	
Blechnum occidentale Linnaeus	In	H	4	o	O	
Diplazium Arnottii Brackenridge	E	H	5	c	O,C	
D. marginale (Hillebrand) C. Christensen	E	H	5	c	O,C	
Doodia Lyoni Degener	E	H	4	o	O	
D. Kunthiana Gaudichaud	E	H	4	c	O	
Doryopteris decipiens (Hooker) J. Smith	E	H	3	o	G	
Dryopteris crinalis (Hooker and Arnott) C. Christensen	E	H	5	o	O	
D. cyatheoides (Kaulfuss) Kuntze	E	H	5	a	O,C	
D. dentata (Forster) C. Christensen	In	H	4	o	O	
D. globulifera (Brackenridge) Kuntze	E	H	5	o	O	
D. gongylodes (Schkuhr) Kuntze	I	H	4	o	O	
D. hudsonianum (Brackenridge) Roscoe	I	H	5	o	O	
D. latifrons (Brackenridge) Kuntze	E	H	5	o	O,C	
D. paleacea (Swartz) C. Christensen	I	H	5	o	O,C	
D. stegnogrammoides (Baker) C. Christensen	E	H	5	o	O,C	
Elaphoglossum aemulum (Kaulfuss) Brackenridge	E	E	4	o	O.C	
E. gorgoneum (Kaulfuss) Brackenridge	E	H,E	4	c	O,C	
E. micradenium (Fée) Moore	E	E	3	o	O	
E. reticulatum (Kaulfuss) Gaudichaud	E	E	4	a	O,C	
Lindsaya Macraena (Hooker and Arnott) Copeland	I	H,E	4	a	O,C	
Microlepia setosa (Smith) Alston	E	H	5	o	O	
Nephrolepis cordifolia (Linnaeus) Presl	In	H	4	r	O,C	
N. exaltata (Linnaeus) Schott	I	H	4	a	G,K,O.C	
Pityrogramma ochracea (Presl) Domin	In	H	5	o	G	
Polypodium Haalilioanum Brackenridge	E	E	2	r	O;C	
P. Hookeri Brackenridge	I	E	3	r	O,C	
P. hymenophylloides Kaulfuss	E	E	2	o	O,C	
P. lineare Thunberg	I	E	3	a	G,K,O,C	
P. pellucidum Kaulfuss	E	E	4	o	O,C	
P. pumilum W. J. Robinson	E	E	3	r	O,C	
P. pseudo-grammitis Gaudichaud	E	E	2	a	O,C	
P. Saffordii Maxon	E	E	1	o	O,C	

	I	II	III	IV	V	VI
P. sarmentosum Brackenridge	E	E	3	o	O,C	
P. spectrum Kaulfuss	E	H,E	4	o	O	
P. tamariscinum Kaulfuss	E	E	3	o	O,C	
Pteridium aquilinum (Linnaeus) Kuhn	I	H	4	a	H,G,K,O	
Pteris irregularis Kaulfuss	E	H	5	r	O	
Sadleria cyatheoides Kaulfuss	E	N	5	a	G,K,O,C	
S. Hillebrandii W. J. Robinson	E	Ch	5	r	O	
S. polystichoides (Brackenridge) Heller	E	Ch	5	o	O,C	
S. Souleyetiana (Gaudichaud) Moore	E	N	6	r	O,C	
Stenoloma chinensis (Linnaeus) Beddome	I	H	5	a	H,G,K,O,C	
Tectaria Gaudichaudii (Mettenius) Maxon	E	H	5	r	O	
Vittaria rigida Kaulfuss	I	E	3	o	O	
Gleicheniaceae						
Gleichenia emarginata (Brackenridge) Moore	E	H	4	r	C	
G. glauca (Thunberg) Hooker	I	H	5	c	O,C	
G. linearis (Burmann) Clarke	I	H	5	a	G,K,O,C	
Schizaeaceae						
Schizaea robusta Baker	E	H	1	r	O,C	
Marattiaceae						
Marattia Douglasii (Presl) Baker	E	Ch	6	r	K,O	
Ophioglossaceae						
Ophioglossum pendulum Linnaeus	I	E	3	c	O	
Lycopodiaceae						
Lycopodium cernuum Linnaeus	I	N	1	a	K,O,C	
L. nutans Brackenridge	I	H,E	1	r	O	
L. phyllanthum Hooker and Arnott	I	H,E	1	c	O,C	
L. serratum Thunberg	I	H,E	1	r	O,C	
L. serratum Thunberg variety dentatum Hillebrand	E	H,E	1	vr	C	
Psilotum complanatum Swartz	I	H,E	1	r	K,O	
P. nudum (Linnaeus) Grisebach	I	H,E	1	c	G,K,O	
Selaginella Menziesii (Hooker and Greville) Spring	E	H,E	1	c	O,C	
SPERMATOPHYTA						
Pandanaceae						
Freycinetia arborea Gaudichaud	E	M	4	a	K,O,C	
Potamogetonaceae						
Potamogeton foliosus Rafinesque variety Macellus Fernald	In	HH	2	c	M	

	I	II	III	IV	V	VI
Gramineae						
Bambusa vulgaris (Linnaeus) Schrader	In	MM	4	r	K,O	
Cenchrus echinatus Linnaeus	In	Th	3	c	H,G	
C. echinatus Linnaeus variety Hillebrandianus (Hitchcock) F. B. H. Brown	E	Th	3	c	H,G	
Chloris inflata Link	In	Th	2	c	M,H,G	
C. radiata (Linnaeus) Swartz	In	Th	2	o	H,G	
Chrysopogon aciculatus Trinius	I	H	3	a	H,G,K	
Cynodon Dactylon (Linnaeus) Persoon	In	H	1	c	M,H,G	
Digitaria violascens Link	In	Th	2	c	H,G	
D. pruriens (Trinius) Busse	In	H	3	o	H,G	
D. sanguinalis (Linnaeus) Scopoli	In	H	3	o	H,G	
Echinochloa colonum (Linnaeus) Link	In	Th	3	r	M	
E. crus-galli (Linnaeus) Beauvois variety crus-pavonis (H. B. K.) Hitchcock	In	H	3	r	M,O	
E. stagnina (Retzius) Beauvois	In	H	3	r	M	
Eleusine indica (Linnaeus) Gaertner	In	H	2	c	H,G	
Eragrostis amabilis (Linnaeus) Wight and Arnott	In	Th	2	o	H	
E. cilianensis (Allioni) Link	In	Th	2	o	H	
E. deflexa Hitchcock	E	H	2	r	H,G	
E. grandis Hillebrand	E	H	2	r	H,G	
Heteropogon contortus (Linnaeus) Beauvois	I	H	3	a	H,G	
Sorghum halepense (Linnaeus) Persoon	In	H	3	r	M	
Isachne pallens Hillebrand	E	H	2	o	O,C	
Oplismenus hirtellus (Linnaeus) Beauvois	In	H	3	a	G,K,O,C	
Panicum purpurascens Raddi	In	H	3	c	M,H,G,K	
P. koolauense St. John and Hosaka	E	H	1	vr	C	
Paspalum conjugatum Bergius	In	H	2	a	M,H,G,K,O,C	
P. orbiculare Forster	In	H	3	a	H,G,K,O	
Pennisetum setosum (Swartz) L. Richardson	In	H	3	c	G	
Setaria verticillata (Linnaeus) Beauvois	In	Th	3	o	H,G	
Trichachne insularis (Linnaeus) Nees	In	H	3	o	H,G	
Tricholaena repens (Willdenew) Hitchcock	In	H	3	c	H,G	
Cyperaceae						
Carex brunnea Thunberg variety Meyenii (Nees) Kuekenthal	I	H	3	vr	O	
C. sp. (similar to C. sandwicensis)	E	H	3	vr	C	
C. wahuensis C. A. Meyer	E	H	3	o	K,O	
Cyperus alternifolius Linnaeus	In	H	3	r	M	
C. laevigatus Linnaeus	I	H	1	o	M,O	
C. polystachyus Rottboell	I	H	2	o	O.	
C. Prescottianus Hooker and Arnott	E	H	4	r	O,C	
Heleocharis obtusa Schuetes variety enotata Hillebrand	E	H	1	vr	O	
Fimbristylis diphylla Vahl	I	H	3	o	O	
Gahnia Beecheyi Mann	E	H	4	o	O,C	
Kyllinga brevifolia Rottboell	In	H	2	o	M,G	
K. cephalotes (Jacquin) Druce	In	H	2	r	O	

	I	II	III	IV	V	VI
Mariscus angustifolius (Gaudichaud) Kuntze	I	H	4	o	O,C	
M. Meyenii Kuntze	I	H	3	o	O	
Rhynchospora glauca Vahl forma lavarum (Gaudichaud) Kuekenthal	E	H	2	o	K,O	
R. sclerioides Hooker and Arnott	E	H	4	c	O,C	
Scirpus lacustris Linnaeus	In	HH	1	o	M;G,K,O	
S. maritimus Linnaeus variety digynus Boeckler	In	H	3	r	M	
Palmaceae						
Cocos nucifera Linnaeus	In	MM	6	o	M,G,O	
Eupritchardia Martii (Wendland) Kuntze	E	M	6	c	O,C	II
Araceae						
Alocasia macrorrhiza (Linnaeus) Schott	In	N	5	vr	K	
Colocasia esculenta (Linnaeus) Schott variety antiquorum (Schott) Hubbard and Rehder	In	G	5	o	M,K,O	
Lemnaceae						
Lemna minor Linnaeus	In	HH	1	c	M	
Spirodela polyrhiza (Linnaeus) Schleiden	In	HH	1	c	M	
Flagellariaceae						
Joinvillea Gaudichaudiana Brogniart and Gris	I	M	4	r	O	VI-VII
Commelinaceae						
Commelina diffusa Burmann	I	N	3	a	M,H,G,K,O	
Pontederiaceae						
Eichornia speciosa Kunth	In	HH	4	r	M	
Liliaceae						
Astelia veratroides Gaudichaud	E	H,E	4	o	O,C	VIII
Cordyline fruticosa (Linnaeus) A. Chevalier	In	M	5	a	G,K,O	XII-I
Dianella sandwicensis Hooker and Arnott	E	H	4	c	K,O,C,	
Dracaena aurea Mann	I	M	4	r	K,O	V
Smilax sandwicensis Kunth	E	M	4	c	O,C	IV
Amaryllidaceae						
Fourcroya gigantea Vent	In	N	6	o	H,G	
Dioscoreaceae						
Dioscorea bulbifera Linnaeus	In	Ch	4	c	O	
D. pentaphylla Linnaeus	In	Ch	4	r	K	
Musaceae						
Musa sapientum Linnaeus	In	M	6	c	K,O	
Zingiberaceae						
Hedychium flavum Roxburg	In	G	4	o	K,O	V-VII
Zingiber Zerumbet (Linnaeus) Roscoe	In	G	4	a	K,O	VII

	I	II	III	IV	V	VI
Orchidaceae						
Anoectochilus sandwicensis Lindley	E	H,E	3	o	O,C	IX
A. sandwicensis Lindley variety B. Hillebrand	E	H,E	3	o	O,C	XI
Liparis hawaiiensis Mann	E	E	3	o	O,C	IX
Spathoglottis plicata Blume	In	H	4	vr	K	
Piperaceae						
Peperomia elliptibacca C. de Candolle	E	Ch,E	3	r	C	
P. latifolia Miquel	E	Ch,E	3	c	K,O,C	
P. leptostachys Hooker and Arnott	I	N	2	o	G,K	
P. lilifolia C. de Candolle	E	Ch	3	o	O,C	
P. membranacea Hooker and Arnott	E	N	3	c	O,C	
P. membranacea Hooker and Arnott variety brevifolia Yuncker	E	N	3	r	O,C	
P. oahuensis C. de Candolle	E	N,E	3	o	O,C	
P. reflexa Dietrich	I	Ch,E	1	o	G,K,O	
P. sandwicensis Miquel	E	N	3	o	K,O	
Piper methysticum Forster	In	M	4	r	O	
Urticaceae						
Artocarpus incisa Linnaeus	In	MM	5	r	G,K,O	VI
Boehmeria grandis (Hooker and Arnott) Heller	E	M	4	vr	O	VI-VIII
Pilea peploides Hooker and Arnott	I	Ch	1	r	C	
Pipturus albidus (Hooker and Arnott) Gray	E	M	4	c	K,O,C	V-IX
P. Skottsbergii Krajina	E	M	4	r	O	
Touchardia latifolia Gaudichaud	E	M	4	c	O,C	V-VIII
Urera sandvicensis Weddell	E	M	4	vr	O	
Loranthaceae						
Korthalsella complanata (Van Tieghem) Engler	E	E	—	o	K,O,C	
K. cylindria (van Tieghem) Engler	E	E	—	vr	O	
K. sp. (similar to K. complanata)	E	E	—	vr	O	
Santalaceae						
Exocarpus sandwicensis Baillon	E	M	3	r	O,C	V
Santalum Freycinetianum Gaudichaud	E	M	3	o	K,G,O	II-X
Chenopodiaceae						
Chenopodium murale Linnaeus	In	N	3	c	M	
Amarantaceae						
Amaranthus hybridus Linnaeus	In	N	3	c	H,G	
A. spinosus Linnaeus	In	N	3	c	H,G	
Charpentiera obovata Gaudichaud	E	MM	3	c	K,O	IV-IX
Nyctaginaceae						
Ceodes umbellata Forster	I	MM	4	o	K,O	VI-XI

	I	II	III	IV	V	VI
Batidaceae						
Batis maritima Linnaeus	In	N	2	a	M	
Phytolaccaceae						
Phytolacca acinosa Roxburg	In	N	3	o	H,G	
Aizoaceae						
Sesuvium Portulacastrum Linnaeus	I	Ch	2	o	M	
Portulacaceae						
Portulaca oleracea Linnaeus	In	Ch	2	a	M,H,G	
Caryophyllaceae						
Drymaria cordata (Linnaeus) Willdenow	In	Ch	2	a	G	
Menispermaceae						
Cocculus Ferrandianus Gaudichaud	E	Ch	3	o	G,K,O	
Lauraceae						
Cryptocarya oahuensis (Degener) Fosberg	E	M	4	vr	O	
Papaveraceae						
Argemone alba Lestiboudois variety glauca Prain	E	N	4	r	H	
Saxifragaceae						
Broussaisia arguta Gaudichaud	E	M	4	a	O,C	III-XI
Pittosporaceae						
Pittosporum acuminatum Mann	E	M	4	o	O,C	
P. Gayanum Rock	E	M	4	r	O	
P. glabrum Hooker and Arnott	E	M	4	o	O,C	IV-VII
P. spathulatum Mann	E	M	4	o	O,C	V-VII
Rosaceae						
Osteomeles anthyllidifolia Lindley	I	N	3	o	H,G	I-VII
Rubus rosaefolius Smith	In	N	4	o	C	
Leguminosae						
Acacia Farnesiana (Linnaeus) Willdenow	In	N	3	c	H	I-XI
A. Koa Gray	E	MM	4	a	K,O,C	I-IV
Cassia bicapsularis Linnaeus	In	N	4	r	H	XI
C. Leschenaultiana de Candolle	In	N	3	c	H,G	
C. occidentalis Linnaeus	In	N	4	o	H,G	
Crotalaria incana Linnaeus	In	N	3	o	H,G	
C. Saltiana Andrews	In	N	3	c	H,G	
Desmodium triflorum (Linnaeus) de Candolle	In	Ch	1	o	H,G	
D. uncinatum (Jacquin) de Candolle	E	N	3	o	H,G	

	I	II	III	IV	V	VI
Erythrina sandwicensis Degener	E	M	4	vr	H	II
Indigofera suffruticosa Miller	In	N	4	o	G	
Leucaena glauca Bentham	In	M	4	c	H	
Medicago denticulata Willdenow	In	Ch	2	vr	H	
Mimosa pudica Linnaeus	In	N	3	r	G	
Phaseolus lathyroides Linnaeus	In	N	3	c	H,G	
Prosopis chilensis (Molina) Stuntz	In	MM	4	c	M,H,G	
Oxalidaceae						
Oxalis corniculata Linnaeus	In	H	2	c	H,G	
O. corniculata Linnaeus variety viscidula Wiegand	In	H	2	c	H,G	
O. Martiana Zuccarini	In	G	3	c	G	
Rutaceae						
Pelea clusiaefolia Gray	E	M	4	c	O,C	VII-XI
P. oblongifolia Gray	E	M	3	o	O,C	
P. rotundifolia Gray	E	M	4	o	O,C	XI
P. Mannii Hillebrand	E	M	4	r	C	II
P. sandwicensis (Gaudichaud) Gray	E	MM	4	c	O,C	
P. waianaensis Léveillé	E	M	4	vr	O	XI
P. Wawraeana Rock	E	M	4	c	O,C	
P. cinerea (Gray) Hillebrand variety sulfurea Rock	E	M	4	vr	O	
Platydesma campanulata Mann	E	M	4	o	O,C	VII
P. cornuta Hillebrand	E	N	4	r	O	V-XI
Fagara oahuensis (Hillebrand) Engler	E	M	4	o	O,C	VII-X
Meliaceae						
Melia Azedarach Linnaeus	In	MM	4	r	H,G	V-VI
Euphorbiaceae						
Aleurites moluccana (Linnaeus) Willdenow	In	MM	4	a	G,K,O	X-IV
Antidesma platyphyllum Mann	E	MM	4	a	O,C	VI-VIII
Claoxylon sandwicense Mueller	E	M	4	r	O	V-XI
Euphorbia bifida Hooker and Arnott	In	N	2	a	H,G,K	
E. geniculata Ortega	In	Th	3	c	H,G	
E. hirta Linnaeus	In	Th	2	a	H,G	
E. multiformis Hooker and Arnott	E	N	3	o	O	VI-IX
E. Rockii Forbes	E	M	3	c	O,C	III-X
E. thymifolia Linnaeus	In	H	1	o	H,G	
Ricinus communis Linnaeus	In	M	4	r	H,G	
Aquifoliaceae						
Ilex anomala Hooker and Arnott	E	MM	4	c	O,C	V-XII
Celastraceae						
Perrottetia sandwicensis Gray	E	M	3	a	O,C	IV-X

	I	II	III	IV	V	VI
Sapindaceae						
Alectryon macrococcum Radlkofer	E	MM	5	vr	O	
Sapindus oahuensis Hillebrand	E	MM	4	vr	K	
Dodonaea viscosa (Linnaeus) Jacquin	I	M	3	o	H,G	X-II
Elaeocarpaceae						
Elaeocarpus bifidus Hooker and Arnott	E	MM	4	c	O,C	XI-IV
Malvaceae						
Hibiscus Arnottianus Gray	E	MM	4	r	O	VI-XI
H. tiliaceus Linnaeus	In	MM	4	o	H,G,K	
H. Youngianus Gaudichaud	E	N	3	r	G,K	V
Malva rotundifolia Linnaeus	In	N	3	o	H	
Malvastrum coromandelianum (Linnaeus) Garcke	In	N	2	c	H,G	
Sida fallax Walpers	In	N	3	o	H,G	
S. rhombifolia Linnaeus	In	N	2	c	H,G	
Sterculiaceae						
Waltheria indica (Linnaeus) variety americana (Linnaeus) R. Brown	In	N	3	a	H,G,K	
Theaceae						
Eurya sandwicensis Gray	E	M	3	o	O	VII
Violaceae						
Viola oahuensis Forbes	E	Ch	3	r	C	
Flacourtiaceae						
Xylosma hawaiiense Seemann	E	M	4	o	O,C	X-XI
Passifloraceae						
Passiflora edulis Sims	In	N	3	o	K	V
P. foetida Linnaeus	In	N	3	o	H	
Cactaceae						
Opuntia megacantha Salm-Dyck	In	M	—	c	H	
Thymeleaceae						
Wikstroemia elongata Gray variety recurva Hillebrand	E	N	3	r	O	III-XI
W. oahuensis (Gray) Rock	E	M	3	c	K,O,C	V-IX
Lythraceae						
Cuphea Balsamona Chamisso and Schlechtendal	In	Ch	2	a	G,K,O,C	

	I	II	III	IV	V	VI
Myrtaceae						
Eugenia malaccensis Linnaeus	In	MM	4	o	K,O	IV-VI
E. sandwicensis Gray	E	MM	3	a	O,C	VII-XII
Metrosideros collina (Forster) Gray subsp. polymorpha (Gaudichaud) Rock variety glabrifolia (Heller) Rock	E	MM	3	a	K,O	
M. collina (Forster) Gray subsp. polymorpha (Gaudichaud) Rock variety glaberrima (Léveillé) Rock	E	M	3	c	K,O,C	
M. collina (Forster) Gray subsp. polymorpha (Gaudichaud) Rock variety glaberrima (Léveillé) Rock forma sericea Rock	E	MM	3	c	O	
M. collina (Forster) Gray subsp. polymorpha (Gaudichaud) Rock variety incana (Léveillé) Rock	E	MM	3	a	O	
M. collina (Forster) Gray subsp. polymorpha (Gaudichaud) Rock variety Newellii Rock	E	M	3	c	O	
M. collina (Forster) Gray subsp. polymorpha (Gaudichaud) Rock variety prostrata Rock	E	Ch	2	o	C	
M. collina (Forster) Gray subsp. polymorpha (Gaudichaud) Rock variety typica Rock	E	MM	3	c	K,O	
M. macropus Hooker and Arnott	E	MM	3	c	O,C	
M. rugosa Gray	E	M	3	r	C	
M. tremuloides (Heller) Rock	E	M	3	o	O	II
Psidium cattleianum Sabine	In	M	3	r	K	
P. Guayava Linneaus	In	M	4	a	H,G,K,O,C	
Onagraceae						
Jussiaea villosa Lamarck	In	N	3	o	O	
Araliaceae						
Cheirodendron Gaudichaudii (de Candolle) Seemann	E	MM	4	o	O,C	V-VIII
C. platyphyllum (Hooker and Arnott) Seemann	E	MM	4	o	C	VIII-X
Pterotropia gymnocarpa Hillebrand	E	MM	5	vr	C	
Tetraplasandra meiandra (Hillebrand) Harms	E	MM	5	o	O,C	VI-X
T. oahuensis (Gray) Harms	E	M	4	o	O,C	VII-VIII
T. oahuensis (Gray) Harms variety B. (Hillebrand) Rock	E	M	4	r	O,C	
Umbelliferae						
Centella asiatica (Linnaeus) Urban	In	H	3	c	G	
Hydrocotyle verticillata Thunberg	In	H	3	r	O	
Sanicula purpurea St. John and Hosaka	E	H	3	vr	C	

	I	II	III	IV	V	VI
Ericaceae						
Vaccinium dentatum Smith	E	N	3	o	O,C	
Epacridaceae						
Styphelia Tameiameiae (Chamisso) Mueller	E	M	1	c	G,K,O	V
Myrsinaceae						
Suttonia Fernseei Mez	E	M	4	r	C	
S. Hillebrandii Mez	E	M	3	vr	K,C	
S. Lessertiana (A. de Candolle)	E	M	4	c	O,C	I-II
S. sandwicensis (A. de Candolle) Mez	E	M	2	r	O,C	I
Sapotaceae						
Planchonella sandwicensis (Hillebrand) Pierre	E	MM	4	c	O	IV-VII
Ebenaceae						
Diospyros Hillebrandii (Seemann) Fosberg	E	MM	4	o	O	VII
D. sandwicensis (A. de Candolle) Fosberg	E	MM	3	c	O,C	IV
Oleaceae						
Osmanthus sandwicensis (Gray) Bentham and Hooker	E	MM	4	c	K,O,C	XI-II
Loganiaceae						
Buddleia asiatica Loureiro	In	N	3	o	O,C	V-X
Labordia fagraeoidea Gaudichaud	E	M	3	c	O,C	VII
L. glabra Hillebrand	E	N	3	r	C	III
L. hedyosmifolia Baillon	E	N	3	r	C	VII
L. Cyrtandrae (Baillon) St. John	E	N	4	r	O,C	VII
Apocynaceae						
Alyxia olivaeformis Gaudichaud	E	M	3	a	K,O,C	I-V
Pteralyxia macrocarpa (Hillebrand) K. Schumann	E	MM	4	vr	O	I
Rauwolfia sandwicensis A. de Candolle	E	MM	4	r	K,O	
Asclepiadaceae						
Gomphocarpus physocarpus E. Meyer	In	N	3	c	G,K	
Convolvulaceae						
Convolvulus arvensis Linnaeus	In	H	2	o	M	
Ipomoea aquatica Forskål	In	HH	3	vr	M	
I. Bona-nox Linnaeus	I	N	4	a	H,G,K,O	VIII
I. indica (Burmann) Merrill	I	N	3	a	H,G,K	
I. obscura (Linnaeus) Ker-Gawl	In	N	3	c	M	
I. pentaphylla (Linnaeus) Jacquin	In	N	3	c	H,G	
I. pes-caprae (Linnaeus) Sweet	I	Ch	4	vr	M	
I. tuberculata Roemer	In	N	3	c	H,G	
Jacquemontia sandwicensis Gray	E	Ch	3	r	M	

	I	II	III	IV	V	VI
Boraginaceae						
Heliotropium curassavicum Linnaeus	I	Ch	2	r	M	
Verbenaceae						
Lantana Camara Linnaeus	In	M	3	a	H,G,K,O,C	I-XII
Stachytarpheta dichotoma (Ruiz and Pavon) Vahl	In	N	3	a	M,H,G	
S. jamaicensis (Linnaeus) Vahl	In	N	3	c	H,G	
Verbena bonariensis Linnaeus	In	N	3	o	H,G	
Labiatae						
Phyllostegia glabra Bentham variety Macraei (Bentham) Sherff	E	N	4	c	O,C	I-XI
P. grandiflora (Gaudichaud) Bentham	E	N	3	c	O,C	I-XII
P. hirsuta Bentham	E	N	4	r	O,C	V
P. lantanoides Sherff	E	N	3	r	C	X
P. parviflora (Gaudichaud) Bentham	E	N	4	vr	C	X
Stachys arvensis Linnaeus	In	Th	2	o	G	
Solanaceae						
Lycopersicum esculentum Miller variety cerasiforme Hortorum	In	N	3	c	M,H,G	
Nothocestrum longifolium Gray	E	M	4	o	O	V-VI
Solanum nodiflorum Jacquin	I	N	3	a	M,H,G,K	
S. sodomeum Linnaeus	In	N	4	r	H,G	
Physalis peruviana Linnaeus	In	N	3	r	K	
Gesneriaceae						
Cyrtandra sp.	E	N	4	vr	O	
C. cordifolia Gaudichaud	E	M	4	a	K,O,C	II-XI
C. Garnotiana Gaudichaud	E	N	4	r	O	IV-XI
C. grandiflora Gaudichaud	E	N	4	o	O	
C. kalichii Wawra	E	N	4	c	O,C	II-XI
C. kalichii Wawra variety tristis (Hillebrand) Rock	E	N	4	r	O,C	XI
C. laxiflora Mann	E	N	4	r	O	V
C. laxiflora Mann variety grandifolia Rock	E	N	4	vr	O	
C. Lessoniana Gaudichaud	E	M	4	c	O	X
C. longifolia Hillebrand variety calpidicarpa Rock	E	N	4	r	O	VI
C. longifolia Hillebrand variety degenerans (Wawra) C. B. Clarke	E	N	4	o	O,C	
C. paludosa Gaudichaud	E	N	3	o	O	V
C. propinqua Forbes	E	N	4	vr	O	II
C. waiolani Wawra	E	N	4	vr	O	
Plantaginaceae						
Plantago major Linnaeus	In	H	4	o	M	
P. pachyphylla Gray	E	H	4	vr	C	VII-XII

	I	II	III	IV	V	VI
Rubiaceae						
Bobea brevipes Gray	E	MM	3	vr	K,O	VI-VIII
B. elatior Gaudichaud	E	MM	4	a	K,O,C	IV-VIII
Canthium odoratum (Forster) Seemann	I	M	3	o	K	
Coprosma longifolia Gray	E	M	3	o	O,C	II
Gardenia Remyi Mann	E	MM	4	c	O,C	V-VII
Gouldia St.-Johnii Fosberg variety typica Fosberg	E	M	3	o	C	VII
G. terminalis (Hooker and Arnott) Hillebrand variety typica Fosberg	E	M	4	c	O,C	VI-VIII
G. terminalis (Hooker and Arnott) Hillebrand variety coriacea (Hooker and Arnott) Fosberg	E	M	4	o	O,C	VI-VIII
G. terminalis (Hooker and Arnott) Hillebrand variety Wawrana Fosberg	E	M	4	o	O,C	VI-VIII
G. terminalis (Hooker and Arnott) Hillebrand variety macrothyrsa Fosberg	E	M	4	o	O	VI-VIII
Kadua acuminata Chamisso and Schlechtendal	E	M	4	r	O	V-VI
K. fluviatilis Forbes	E	N	3	r	O	II-III
K. glomerata Hooker and Arnott	E	N	4	vr	O,C	VIII-IX
Morinda citrifolia Linnaeus	In	M	4	c	G	X
M. trimera Hillebrand	E	MM	4	vr	O	IV-VI
Nertera depressa Banks and Solander	I	Ch	1	c	O,C	
Psychotria sp.	E	M	4	vr	O	V
Richardsonia scabra (Linnaeus) St. Hilaire	In	Ch	3	a	H,G	
Straussia Fauriei Léveillé	E	M	3	r	O,C	VII-IX
Straussia sp.	E	M	4	vr	O	V
S. kaduana (Chamisso and Schlechtendal) Gray	E	M	4	a	K,O,C	IV-VII
S. leptocarpa Hillebrand	E	M	4	r	O,C	VI-VII
S. Mariniana (Chamisso and Schlechtendal) Gray	E	M	4	c	K,O,C	IV
Cucurbitaceae						
Momordica Balsamina Linnaeus	In	N	3	o	M	
Campanulaceae						
Clermontia kakeana Meyen	E	M	4	c	O,C	V-XI
C. oblongifolia Gaudichaud	E	M	4	vr	O,C	II-III
C. persicifolia Gaudichaud	E	M	4	o	O	III-X
Cyanea acuminata (Gaudichaud) Hillebrand	E	N	4	o	O	V-X
C. angustifolia (Chamisso) Hillebrand	E	M	4	c	O	V-XI
C. Grimesiana Gaudichaud	E	N	5	c	O	VI-XI
Lobelia Gaudichaudii A. de Candolle	E	N	4	r	C	IX-X
L. hypoleuca Hillebrand	E	N	4	o	O,C	IX-X
L. oahuensis Rock	E	M	4	r	C	VII-VIII
Rollandia angustifolia (Hillebrand) Rock	E	N	4	o	O,C	VI-VII
R. calycina (Chamisso) G. Don	E	N	4	o	O,C	VII-VIII
R. crispa Gaudichaud	E	N	4	c	K,O	II-V
R. Humboldtiana Gaudichaud	E	N	4	r	O	XI

	I	II	III	IV	V	VI
R. lanceolata Gaudichaud variety kipapaensis Hosaka	E	N	4	r	O	V-VI
R. lanceolata Gaudichaud variety tomentosa Rock	E	N	4	o	K,O	V-VII
R. longiflora Wawra	E	N	4	o	K,O	II-V
R. St.-Johnii Hosaka	E	N	3	r	C	VII-IX
Trematolobelia macrostachys (Hooker and Arnott) Zahlbruckner	E	N	4	r	O,C	X-XII
Goodeniaceae						
Scaevola cerasifolia Skottsberg	E	M	3	r	O,C	V-XI
S. Gaudichaudiana Chamisso	E	M	3	a	G,K,O,C	I-XII
S. Gaudichaudiana Chamisso forma leucocarpa Skottsberg	E	M	3	vr	O	VII-XI
S. glabra Hooker and Arnott	E	M	4	c	O,C	III-XI
S. mollis Hooker and Arnott	E	M	3	c	O,C	III-XI
S. procera Hillebrand	E	M	3	r	O,C	IV-XI
S. Skottsbergii St. John	E	M	3	vr	G	VII-XI
Compositae						
Acanthospermum australe (Loefling) Kuntze	In	Th	2	c	H,G	
Adenostemma Lavenia (Linnaeus) Kuntze	In	N	3	o	O	
Ageratum conyzoides Linnaeus	In	Th	3	a	M,H,G	
Ambrosia artemisiaefolia Linnaeus	In	N	2	a	H,G	
Artemisia vulgaris Linnaeus	In	N	3	c	H,G	
Bidens macrocarpa (Gray) Sherff	E	N	3	o	O,C	IV-XI
B. pilosa Linnaeus	In	Th	3	a	M,H,G,K	
B. pilosa Linnaeus variety minor (Blume) Sherff	In	Th	3	c	G,K	
Crepis japonica (Linnaeus) Bentham	In	Th	4	c	G,K,O,C	
Dubautia laxa Hooker and Arnott variety Bryanii Sherff	E	N	4	r	O,C	IX-XI
D. laxa Hooker and Arnott variety pseudoplantaginea Skottsberg	E	N	3	vr	O,C	VII-X
D. laxa Hooker and Arnott variety obovata forma glabrescens Sherff	E	N	4	r	C	
D. plantaginea Gaudichaud	E	M	4	vr	C	X-XII
Emilia sonchifolia (Linnaeus) de Candolle	In	Th	4	a	H,G	
Erigeron albidus (Willdenow) Gray	In	Th	3	a	H,G	
Erechtites hieracifolia (Linnaeus) Rafinesque	In	Th	4	a	G,K,O,C	
Eupatorium adenophorum Sprengel	In	N	3	vr	C	
Galinsoga parviflora Cavanilles	In	Th	2	c	G	
Gnaphalium sandwicensium Gaudichaud	E	Th	2	o	H	
Hesperomannia arborescens Gray	E	M	4	r	O	V-VII
Lipochaeta lobata de Candolle variety leptophylla Sherff	E	N	3	vr	H	II
Pluchea indica (Linnaeus) Lessing	In	N	3	c	M	IX
Sonchus oleraceus Linnaeus	In	Th	4	a	M,H,G	
Verbesina encelioides (Cavanilles) Bentham and Hooker	In	N	3	o	M	
Vernonia cinerea (Linnaeus) Lessing	In	Th	3	a	H,G	
Xanthium saccharatum Wallroth	In	N	4	o	M,H	

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OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIII November 1, 1937 Number 18

Liliaceae of Southeastern Polynesia[1]

By CARL SKOTTSBERG

BOTANICAL GARDENS, GÖTEBORG, SWEDEN

CORDYLINE Commers.

Cordyline terminalis (L.) Kunth.

Cordyline fruticosa (L.) A. Chev.: Cat. Pl. Jard. Bot. Saigon, 66, 1919 (non Guép., 1855).

Tuamotu Islands: Hao, Boring Bay, cultivated in village, 1 m., May 19, 1934, *St. John 14416.*

Austral Islands. Rimatara: Anapoto, open woods, 3 m., Sept. 4, 1934, *St. John and Fosberg 16880;* stream near Mutuaura, moist ravine, 25 m., Sept. 5, 1934, *Fosberg 12052.* Rurutu: Paparai Valley, shaded hillside, 50 m., Aug. 28, 1934, *St. John 16690.* Tubuai: Taitao, northeast slope, edge of forest, 320 m., Aug. 6, 1934, *St. John and Fosberg 16341.* Raivavae: south side of pass south of Raurua, edge of wood, 80 m., Aug. 3, 1934, *St. John and Fosberg 15815;* northwest slope of Pic Rouge, woods, 140 m., Aug. 5, 1934, *St. John and Fosberg 15950;* Hotuatua Islet, rocky hillside, 15 m., Aug. 11, 1934, *St. John and Wight 16116.*

Mangareva Islands. Agakautai: west side, in woods on sandy flat, 5 m., June 8, 1934, *St. John 14945.* Taravai: northeast end, thicket in village (probably cultivated), 5 m., June 1, 1934, *St. John 14799.* Akamaru: north side in thicket, 4 m. (occasionally up to 100 m.), May 29, 1934, *St. John 14699.* Aukena: Point Mata Kuiti, thicket near shore, 5 m., May 28, 1934, *St. John 14640.*

[1] Mangarevan Expedition Publication 18.

Rapa, Maungaeae, east of Mangaoa Peak, dense moist woods, 250 m., July 4, 1934, *St. John and Maireau 15367.*

Pitcairn, flatland on wooded slope, 100 m., June 13, 1934, *Fosberg and Christian 11240.*

Henderson Island: northwest end, cliffs above landing in dense forest, 30 m., June 21, 1934, *Fosberg 11351;* west end, jungle on elevated dissected coral, 33 m., June 18, 1934, *St. John and Fosberg 15415.*

The Polynesian plant with wide leaves belongs to variety *ti* of Baker (1, p. 540).[2]

DIANELLA Lam.

All specimens of *Dianella* collected on the expedition belong to *D. intermedia* in the sense of F. B. H. Brown (4). The leaves are comparatively wide, the keel and margin scabrid by minute hyaline spines which in some specimens are quite conspicuous, in others much less so; but no specimen is quite smooth. The flowers in Brown's specimens are greenish or lilac, the color being quite variable. (See table, page 242, for color and flower size of specimens described in this paper.) Several specimens from various islands bear seeds which are all of the same type (fig. 1, *a, b*).

I have attempted to find the relations between *D. intermedia* of Brown and the original plant as described by Endlicher from Norfolk Island, but I have seen only one specimen of this collected by Backhouse (Kew Herbarium). The leaves are strongly revolute, at least when dry, narrower than in most Polynesian plants, the panicle narrow but of the same type as in other specimens. Fragments of flowers remain which are sufficient to show that their size is the same. The outer tepals are 7-veined, the inner 5-veined, whereas in most Polynesian forms they are 5-veined and 3-veined respectivly. Variety *marquisensis* Brown agrees with the Norfolk plant, and variety *gambierensis* is said to have both series 5-nerved. Previously, Brown has established a variety *norfolkensis* Brown for *D. intermedia* from Norfolk, New Zealand, and Fiji (3, p. 11) based on a specimen from New Zealand. According to the description, the latter agrees perfectly with all New Zealand plants which I examined but it differs from the Norfolk plants. The result is that variety *norfolkensis* does not occur in

[2] Numbers in parentheses refer to Literature Cited, p. 244.

Norfolk Island unless more than one form is found there and one of them is the same as the one from New Zealand. I have not seen any material from Fiji, but a flowering and fruiting specimen from Fiji is described by Brown under variety *norfolkensis* (3, p. 11).

Kunth (12, p. 53) refers only the type from Norfolk to *D. intermedia* of Endlicher whose description is copied. The outer tepals are greenish with base and tip tinged lilac, the inner whitish with a green center. These colors fit Polynesian plants quite well. The inner tepals are 5-nerved according to Kunth, and when the inner tepals have 5 complete nerves, the outer usually have 7. Baker (1, p. 578) describes the perianth as pale blue and only 2 lines long, but this figure must be incorrect since no form of *D. intermedia* ever has such small flowers.

The New Zealand *D. intermedia* is widespread in the islands and common in herbaria, so that authors have most likely formed their idea of Endlicher's species from New Zealand material. A New Zealand specimen is one of the reference types of variety *norfolkensis* Brown, and his description fits all the specimens I have seen. The species is well represented in the Kew Herbarium. All the specimens are alike and answer to the description of Cheeseman (5, p. 320) and Brown. They differ from all others in their lax and large, repeatedly dichotomous panicles with long and slender, subumbellately arranged pedicels, only single Polynesian specimens approaching them. The number of tepalic veins is 5 and 3 as in the majority of southeastern Polynesian forms, and in variety *norfolkensis* from Fiji as well as in a plant from Tahiti (Kew Herbarium), but these numbers do not occur in the Norfolk plant as far as is known. The leaf width is about the same in all. Unfortunately fruit and seeds of the Norfolk *D. intermedia* have not been described, and until they are known nothing definite can be said of its relation to other forms. It seems likely that the seed type is of great systematic importance in this case. One of the two types known (fig. 1, *a, b*) is found in plants from Raiatea, Austral Islands, Rapa, and Henderson Island. From Brown's description, Fijian plants also belong here, and it is probable that the same type is found in Tahiti. The other type (fig. 1, *c*) is peculiar to the New Zealand form. In the Kew Herbarium there are several fruiting specimens from New Zealand. The seed shape is uniform, lengths ranging between 2.8 and 3.5 mm. (average 3 mm.), widths 2-2.1 mm., and thickness 1.4-1.5 mm. It is evident from Brown's description that he

found the same kind of seeds in his specimens. If I am right, his variety *norfolkensis* includes three forms.

Concerning *D. intermedia* in New Caledonia, the Kew Herbarium contains two sheets of the type material of *Anthericum adenanthera* Forster, named *D. intermedia.* Baker (1, p. 577) refers Forster's species to *D. ensifolia* (L.) Red. The two specimens in question have the habit of the New Zealand plant, but unfortunately they lack flowers and fruit. As no less than four species of *Dianella* have been reported from New Caledonia, besides the peculiar shrubby *D. austrocaledonica,* Forster's species may be a mixture.

The Norfolk *D. intermedia* seems to approach *D. ensifolia* closely, but according to Baker the latter is a caulescent species, the former acaulescent. There is hardly any strict limit between these two types; both are scabrid and have 5-nerved inner tepals, and leaf width and flower color are variable in both, but the seeds of *D. ensifolia* as described by Baker (1) are quite distinct from the seeds of the various forms of *D. intermedia,* and resemble the seeds of *D. sandwicensis,* a species reduced to *D. ensifolia* by Baker. It is possible that the Hawaiian plant was used for the description just as it served Kunth for his description of *D. odorata* Blume.

Kunth used the number of veins of the tepals as the main distinction between the species groups. If we follow him, Brown's Polynesian *D. intermedia* should be divided between the two groups, 5-7-nerved and 3-5-nerved, and consequently belongs to at least two different species. To me it seems unwise to lay such great weight on this character in this case. The geographical distribution is not in favor of such an action, and two additional veins are sometimes developed in otherwise 3-nerved inner tepals. The presence or absence of blue pigment does not serve as a basis for specific distinction (see table 1), especially in the specimens from Henderson Island, all of which belong to the same variety. Neither does the specimen from Raiatea (no. *17242*) nor that from Rurutu (no. *16684*), both of which have clear blue flowers, seem to be distinguishable from whitish-greenish-purplish-flowered forms. The common color in Tahiti is white or pale yellow (?) tinged with green (9, p. *229*).

Dianella intermedia Endl. var. **punctata** F. B. H. Brown (fig. 1, *a*).

Outer tepals 5-veined, inner 3-veined, especially the former punctate under a lens. Reported by Brown from the Marquesas, Austral Islands, and Rapa. The degree of punctuation varies considerably and there are forms (table 1) where

the dots are few or wanting, but these do not seem to be distinguishable from the rest, as there is no sharp limit between them. Specimens without dots should be referable to variety *nukuhivensis* Brown (Marquesas, Tahiti, Raiatea) but if no better characteristics are found than those indicated, there is little reason to leave it standing.

Society Islands: Raiatea, turfy slope on the Temehani plateau, 500 m., Oct. 5, 1934, *St. John 17242.*

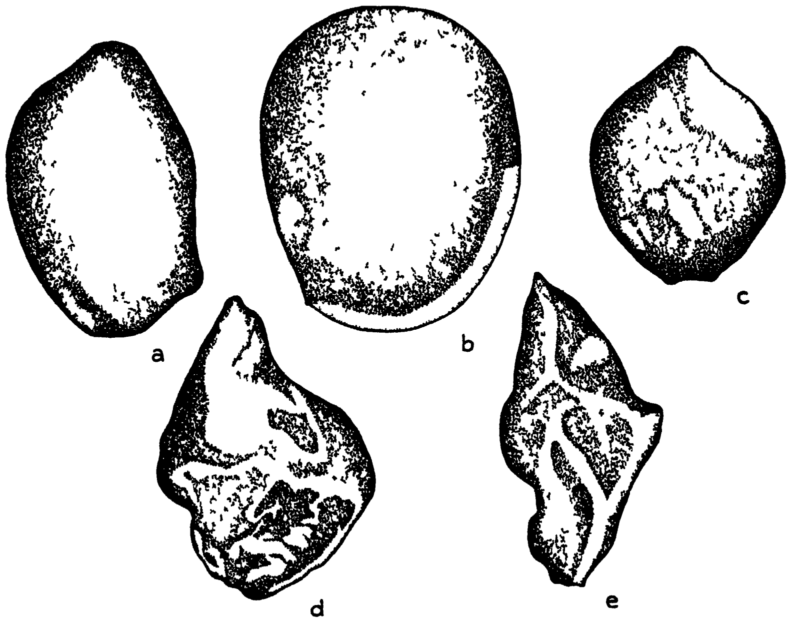

FIGURE 1—Seeds of *Dianella* *a*, *D intermedia* var. *punctata*, no. 16684; *b*, *D intermedia* var. *gambierensis*, no 15121; *c*, the New Zealand variety, Colenso no 1554, *d*, *e*, *D sandwicensis*, Skottsberg no 161. All × 10

Austral Islands. Rurutu: open grassy ridges along road southwest of Moerai, Aug. 26, 1934, *St. John 16684*, "Perianth within clear blue, petals without lined up the middle with reddish brown, sepals outside reddish brown, fruit oval-fusiform, bright blue." Tubuai: low land west of Mataura, Aug. 16, 1934, *Fosberg and Anderson 11805*, "Flower white, purplish tinged", a stout caulescent form with wide leaves; Rautaro Islet, grassy openings in woods on coral sands, Aug. 19, 1934, *St. John 16381*, "Perianth parts white within, without white, streaked down the middle with green or brownish purple", less

high but as wide-leaved as no. *11805.* Tapapatauai Islet: in open woods on coral sands, Aug. 19, 1934, *St. John 16418,* "Flower white, without greenish or purplish tinged", very like no. *11805.* Raivavae: Motu Tehau, on coral gravel, 1 m., *St. John and Wight 16131,* "Flower bluish", seeds larger than in other specimens of the collection. South side, pass south of Raiurua, in grass at edge of woods, Aug. 3, 1934, *St. John and Fosberg 15822,* "Flower purplish"; south slope of Pic Rouge, 60 m., shaded ledges in woods, Aug. 5, 1934, *St. John and Fosberg 15975,* "Fruit ellipsoid, china blue." Hotuatua Islet, dry hillside, 8 m., Aug. 11, 1934, *St. John and Wight 16104,* "Flower whitish."

Rapa: south side, peak between Ahurei Bay and Atanui Valley, grassy ledges at base of small cliff, 150 m., July 3, 1934, *Fosberg 11367,* "Flower outer parts purple, inner ones pale blue-purple, fruit purple"; cliffs and slopes above Area, 90 m., ledges on cliffs, July 3, 1934, *Fosberg 11379,* "Flower white, greenish outside", a narrow-leaved form with smallish seeds; Mount Taga above watering place, 50 m., July 4, 1934, *Fosberg 11395,* "Sepals purple, petals bluish lavender"; Taratika, east side of Mount Perahu, precipitous bushy slope, 590 m., July 21, 1934, *St. John, Fosberg and Maireau 15677,* "Flower inside white, outside purplish, fruit purplish, fusiform." Tapui Islet, rocky grassy slope, 15 m., July 9, 1934, *Fosberg 11449,* "Flower whitish inside, brownish outside." Tauna Island, coral ground, 1 m., July 15, 1934, *St. John and Wight 15550.*

Pitcairn, summit of precipice above The Rope, 200 m., July 14, 1934, *St. John 15005,* "Flower said to be blue," leaves almost smooth. This and other sterile forms are, of course, referred here with hesitation.

Dianella intermedia Endl. var. **gambierensis** F. B. H. Brown (fig. 1, *b*).

Tepals more or less dotted, outer 5-7-veined, inner 5-veined in the specimens examined by me, thus differing from Brown's description, "both series faintly punctate and 5-veined." In venation my form agrees better with variety *marquisensis* Brown (Marquesas), but this has less distinctly punctate tepals, and the inner are wider than the outer. This is not the case in the Henderson plant seen by me, but one specimen examined shows almost no dots. Further, the type of variety *gambierensis* (Henderson, Mangareva) came from Henderson (Quayle 394), although the variety was named for Mangareva (Gambier). Forms with only 5 veins well developed are transitional and it might be better to recognize only one variety.

Henderson Island: north end, moist jungle on elevated dissected coral, 33 m., June 17, 1934, *St. John and Fosberg 15116;* same locality, *St. John and Fosberg 15121,* "Flowers blue"; near center, jungle on elevated dissected coral, 30 m., June 20, 1934, *St. John and Fosberg 15157,* "Sepals bluish, petals white, fruit blue, fusiform"; same locality, *St. John and Fosberg 15167,* "Perianth reflexed, sepals dull purplish, petals white."

These specimens are distinctly caulescent. The panicle is narrow with short, dense racemes and recalls *D. multipedicellata* Degener (8).

Besides *D. intermedia,* Brown also lists *D. odorata* Blume and *D. sandwicensis* Hooker and Arnott from the Marquesas, the latter two belonging to the species with smooth leaves. Kunth united them under the name *D. odorata,* and used a specimen of Gaudichaud's from Hawaii for his description (12, p. 51). Hillebrand followed him in referring the Hawaiian species to *D. odorata* (10, p. 445). Baker (1, p. 577) referred both to *D. ensifolia,* a scabrid species. When I examined my own material (13), only one *Dianella* had been recognized in Hawaii, and consequently this was called *D. sandwicensis* (13, p. 216). Lately three species have been segregated by Degener, which have made it necessary to examine Hooker and Arnott's type, because their diagnoses (11, p. 97) say practically nothing. The Kew Herbarium contains two sheets, both from Oahu, which are perfectly smooth. One of these has wider leaves (to 22 mm.), the flowers are rather small, with tepals 5-6 mm. long, the outer 5-veined, the inner 3-veined. The other specimen which has no flowers has strongly revolute leaves (at least in a dry state). Their width cannot be determined but seems not to exceed 12 or 13 mm. Unfortunately there are no fruits or seeds, but *Skottsberg 161,* which is in every respect like the type, is in flower and fruit. The seeds (fig. 1, *d, e*) are quite characteristic and differ markedly from those of all forms of *intermedia.* I have seen many other specimens from Oahu, and all show the same type of seed, rather irregular in outline, angular and ribbed, with one or both ends pointed. They have been described and figured by Degener (6). The same kind is found in a specimen of Hillebrand's labeled "Ewa, Waiawa, March 1850" (Kew Herbarium). His description, however, calls them "ovoid, compressed, and margined", suggesting a type more like that of *D. intermedia.* From our present knowledge, Hillebrand's Hawaiian material must be a mixture, undoubtedly including *D. lavarum* Degener (7) from the island of

Hawaii. This has seeds of the *intermedia* type. It is doubtful whether or not *D. multipedicellata* Degener (8) is specifically distinct from *D. sandwicensis*. Fruit and seeds have not been collected.

Brown's *D. sandwicensis* from Marquesas (4, p. 153) is apparently very like specimens from Oahu. Although the seeds are not mentioned, we have no reason to doubt that the range of *D. sandwicensis* extends to the Marquesas. It is more difficult to place Brown's *D. odorata,* also from the Marquesas, which is said to be of frequent occurrence in Hawaii. But what is *D. odorata* Blume? In order to find this out, it is necessary to study Blume's type and also plants of Loureiro and Rumphius referred by Kunth to *D. odorata*. It remains to be settled whether Brown's Polynesian plant is the same. According to Kunth, *D. odorata* belongs to the group with 5-veined inner tepals. Brown's *D. odorata* has 5-7-veined outer, and 5-veined inner tepals. A critical revision of the whole genus is needed. The taxonomic value of the characters, smooth versus scabrid leaves, has yet to be settled.

ASTELIA Banks et Solander ex R. Br.

Astelia rapensis, new species (fig. 2).

Subg. Asteliopsis, sect. Periastelia.—Robusta, dense caespitosa caudice longo valido. Folia subplana, majora 70-90 cm. longa et 3.5-4 cm. lata, in sicco chartacea, supra opace viridia-olivacea, subtus pallidora, cinerea, costa mediana subtus incrassata, nervi laterales numerosi utrinque incrassati, duo utroque latere ceteris paulum crassiores, valde approximati, subconfluentes; transversi nulli. Vagina longissime squamosa, niveo-sericea; lamina supra more Asteliarum pelliculosa, squamis mox caducis, subtus appresse squamosa et lanigera, squamis caducis. Planta ♀ solum cognita. Scapus ad 67 cm. longus visus, usque spatham infimam ad 42 cm., dense squamoso-lanuginosa. Panicula ad 25 cm. longa visa, spathis 4, infima foliacea 6.5-21 cm. longa et 1.5-3.4 cm. lata. Racemi 6.5-14.5 cm. longi, densiflori, infimi basi virgati. Bracteae liberae, ovatae, acuminatae, subhyalinae, longe villosae, 4.3-5.5 mm. longae et 2.2-3.3 mm. latae. Pedicelli 3-4 (-5) mm. longi. Flores expansi ad 17 mm. diam. Tepala brevissime connata, ovato-lanceolata, viridia, externa (6-) 7-8 mm. longa et (2.5-) 3-4 mm. lata, apice minute cucullata, dorso sparse squamosa, interna (5.5-) 6-7.5 mm. longa et 2.5-3 mm. lata dorso secus medianum squamis nonullis donata. Staminodia lageniformia, 2.2-3 mm. longa (parte libera 1.5-2.5 mm.), inferne 0.7-0.9 mm. crassa, apiculata; antheris nullis. Ovarium 3 mm. longum et 2.8 mm. diam., profunde sulcatum triloculare, stylo 1.2 mm. longo, stigmate generis. Fructus non suppetunt. Ins. Rapa, Kaimaru, alt. 500 m., legerunt *St. John et Maireau 15513*. Typus in herb. Bishop Mus.. Taratika, alt. 450 m., *St. John et Maireau 15573*.

In the following supplementary description, collectors' notes are cited:

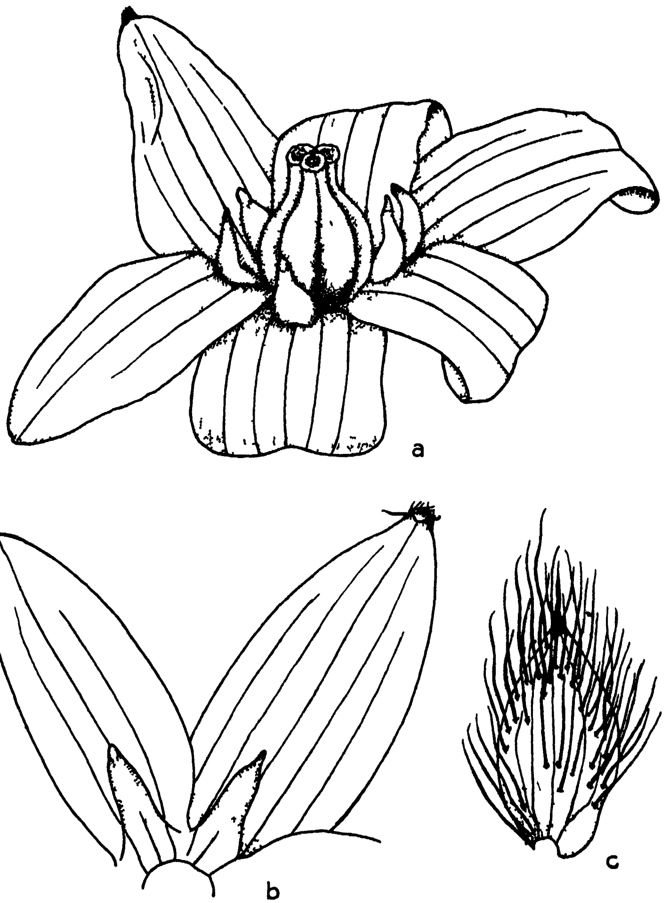

FIGURE 2—*Astelia rapensis,* no. 15513: *a,* female flower; *b,* outer and inner tepal with staminodes; *c,* bract. All × 5.

Erect, caudex long, ascendent (to 20 cm. long observed), 3-4 cm. thick, covered with sheaths and with vascular bundles of macerated leaves; longest root left about 40 cm. Leaves "almost flat, slightly pleated, one fold on each side", dull green above with a very thin film of 1.5-2 mm. long scales with little wool at base, the film gradually wearing off, ash gray beneath with a thin but dense cover of wool tufts with few scales mixed in, midrib with a cover of 2-2.5 mm. long, narrow scales surrounded with the usual basal wool, the same kind of scales forming a fringe along the margin. The midrib is, as

TABLE 1.—DIANELLA INTERMEDIA IN POLYNESIA

Locality	Specimen	Width of leaves in cm.	Color of Flower	Size of tepals in mm.		Size of seeds in mm.
				Outer	Inner	
Raiatea	17242	1.5-2.0	clear blue	7.2x2.5 d[3]	6.5x2.5 (d)	2.8-3.3x1.5-2.0[4]
Rurutu	16684	1.5 +	clear blue, reddish brown without	6.5x2.5 d	6.5x2.5 d	3.5x2.5x1.5
Tubuai	11805	2.5-3.0	white, purplish-tinged	6.5x2.5 d	6.2x2.0 (d)	
Tubuai	16381	2.5-3.0	as 11805, outside green and brown-purple	6.2x2.7	5.5-6.0x3.0	
Tubuai	16418	2.0-2.5	white, tinged outside green and purple	6.5x3.0	6.0x3.0	
Raivavae	15822	2.0	purplish	6.2x2.5 d	5.5-6.0x2.0 d	4.0x2.5x1.8 (n. 15975)
Raivavae	16104	2.0	whitish			
Raivavae	16131	2.2	bluish			4.5-5.0x3.0x2.0
Rapa	11367	2.0-2+	sepals purple, petals pale blue-purple	6.0x2.2 d	5.0x2.0 (d)	3.2-3.8x2.5x1.6-2.0
Rapa	11379	1.0-1.2	white, greenish outside	6.2x2.0 d	5.0x1.8 (d)	
Rapa	11394	2.0-2.5	white, brownish outside	6.0x2.2 d	6.0x2.5 (d)	3.0-3.3x2.0-1.8x1.5
Rapa	11395	1.9-2.1	sepals purple, petals bluish lavender	5.5x2.0 d	5.5x2.3 (d)	3.5-3.8x2.5x1.5
Rapa	11449	2.0	white, brownish outside	6.3x2.4 d	6.0x2.3 (d)	
Rapa	15677	2.0	white, purplish outside	6.0x2.0 (d)	5.0x1.6 (d)	3.2-3.5x2.0-2.5x1.5
Pitcairn	15005	1.5-1.8	blue			
Henderson	15121	2.5-3.0	blue	5.0x2.3 d	4.5x2.0 d	4.0x3.2x2.3
Henderson	15157	1.8-2.2	sepals bluish, petals white	6.0x2.1 (d)	6.0x1.6 (d)	3.8x2.6x2.0
Henderson	15167	1.5-2.0	sepals dull purple, petals white	6.0-7.0x2.2	6.0-7.0x1.5-1.8	3.5x4.0x2.0

[3] d=tepals plainly punctate; (d)=tepals inconspicuously punctate or with but few dots.
[4] Not ripe, very flat.

usual, little conspicuous on the upper face, and less thickened beneath than in many other species. Of the very numerous lateral veins 8-10 on each side of the midrib are stronger, and of these 2 on each side stand out, forming, in the lower portion of the blade, a double costa; higher up, the distance between them increases to 1 or 2 mm. and the outer, which is a little weaker, gradually gets thinner and disappears. The sheath is as much as 6 cm. wide with a fleshy central portion and thin, semi-transparent wings. The scales forming the silky cover attain as much as 3 cm. in length. In no. *15513* the lowest raceme has 1 or 2, the next 1 branch; the racemes have a sterile proximal portion of 2-2.5 cm. Flowers "green, or slightly streaked or spotted". The rachis and pedicels are white with scales. No. *15573* is a smaller specimen with scape only 35 cm. long and leaves not over 45 cm. long and 3 cm. wide.

Rapa: Kaimaru, south side of Mount Perahu, in moist thicket of steep ridge, alt. 500 m., *St. John and Maireau 15513;* Taratika, east side of Mount Perahu, on wind swept crest of precipice, alt. 450 m., *St. John and Maireau 15573.*

The discovery of an *Astelia* in Rapa is not unexpected but still is of great interest. In habit the new species comes near *A. veratroides* and its allies in Hawaii, and the Marquesas *A. tovii,* but it differs from all in the presence of a double lateral costa, approaching the Tahitian *A. Nadeaudii* to which otherwise it is not related. It lacks the transverse veinlets characteristic of *A. tovii* (14, p. 48), and the bracts are not concrescent with the pedicel as in this species. The flowers are larger than in all the other species of section Periastelia. Staminodes of the same length are found in *A. menziesiana* Sm., but here as well as in all other Hawaiian species, small sterile anthers are developed, whereas *A. rapensis* and *A. tovii* show no trace of an anther. Of the latter a form with long filaments is known, *Adamson and Mumford 590* (14, p. 49).

Through the discovery of *A. rapensis* the area of section Periastelia is extended south. From the geographical position of Rapa we could have expected a species with its closest relative in Tahiti, but *A. Nadeaudii* belongs to a different subgenus. A connection between Hawaii and southeastern Polynesia via the Marquesas is thus established.

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OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIII November 5, 1937 Number 19

Some Rubiaceae of Southeastern Polynesia[1]

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The results of a critical study of the Rubiaceae collected in southeastern Polynesia by the Mangarevan Expedition of Bernice P. Bishop Museum in 1934 are presented here. The work has been carried on in the herbarium of the Museum, and thanks are due to the Director, Dr. Peter H. Buck, and the Curator of Collections, Mr. Edwin H. Bryan, Jr., for permission to use the extensive collections of Polynesian plants housed there, as well as to the former Director, Dr. H. E. Gregory, and the Trustees of Bishop Museum for including me as a member of the expedition on which the specimens here treated were collected. I also wish to thank Dr. Harold St. John who kindly examined and photographed several types in European herbaria.

This collection has yielded a considerable number of new species, varieties, and forms, and has made possible a far better understanding of a number of previously known ones.

The genera *Psychotria, Ixora,* and *Coprosma* are the best represented genera of the Rubiaceae in southeastern Polynesia. The species of the first two, as well as of most of the other genera represented seem to be more closely related to those of western Polynesia and Melanesia than to those of any other region. The genera *Nertera* and *Coprosma* have an antarctic distribution in general, but it is difficult to speculate on the origin of the southeastern Polynesian species. The species of *Nertera* represented occurs from America across the Pacific to Malaysia, while the southeastern Polynesian *Coprosma,* except *C. Cookei,* form a closely related group with no very obvious

[1] Mangarevan Expedition Publication 19.

affinities. *C. Cookei* is closest to *C. acutifolia* of the Kermadec Islands, north of New Zealand.

Discussion of possible former land connections within the region under consideration is of doubtful value when based on the species of only one family. However, the existence of the same or closely related species of *Coprosma* and *Canthium* in Rapa and Pitcairn, *Ixora* and *Canthium* in Rapa and the Austral Islands, and *Ixora* in Raivavae and the Cook Islands, is at least suggestive. If similar relationships are found in other families of plants, and animals as well, then they may be shown to have some significance.

In this paper, with the exception of two varieties of *Coprosma taitensis* and two of *Canthium barbatum,* plants not collected on the Mangarevan Expedition are discussed only incidentally. Several of the genera concerned, such as *Ixora* and *Psychotria,* need revision as a whole, or at least the entire Pacific representation needs revision.

Two species at least, *Morinda citrifolia* and *Gardenia tahitensis,* and possibly a third, *Guettarda speciosa,* were carried from island to island by Polynesians in ancient times. Six exotic cultivated species and one weed are noted.

HEDYOTIS

In order to determine the generic relationships of certain plants hitherto assigned to the genera *Kadua* and *Gouldia,* some study has been made of the genera of the Hedyotideae to which the plants obviously belong. This study has by no means progressed far enough to attempt a realignment of the genera of the Hedyotideae, but my present feeling is that a broad concept of the genus *Hedyotis,* essentially similar to that proposed by Endlicher (Gen. Pl., 548, 1836-40), seems the most satisfactory.

No two workers who have treated many species of this relationship have agreed as to which species to assign to *Oldenlandia* and which to *Hedyotis* or other related genera. No two treatments agree on which of the various proposed segregates should be maintained. *Kadua* is apparently separated on the single point that the seeds are attached at the edge, rather than peltately. This character was broken down as early as the time of Hillebrand (Fl. Haw. Is., 158, 1888), as he observed that in *K. glomerata* and *K. centranthoides* the attachment is peltate. In all the extra-Hawaiian species of *Kadua* that have been described, the seeds are peltate. Furthermore, the Hawaiian species only appear to have the seeds attached at the edge because they are

so crowded as to become higher than wide, and the attachment is at the bottom, actually in the same position as in the peltate ones of other species. These facts all indicate that a narrow generic concept is difficult to apply in this group.

Schumann (Nat. Pflanzenf., Teil 4, Abt. 4, p. 24, 1891) takes a more or less intermediate position, maintaining *Kadua* and some other segregates, but combining the majority including *Hedyotis,* under *Oldenlandia.* He points out no characters separating *Kadua* except the attachment of the seeds. He gives no reason for using the name *Oldenlandia* instead of *Hedyotis.* The latter is the correct name to be applied if these two are combined, as they were both published at the same time, and Wight and Arnott (Fl. Peninsulae Indiae Orientalis, Prodr., **1**:405, 1834), the first writers to combine them, chose *Hedyotis.*

The characters pointed out by Gray (Am. Acad., Proc., **4**:312-318, 1860) as satisfactorily separating the genera concerned, such as the thickness of the capsule wall and the dehiscence of the capsule, may prove sufficient to separate subgenera, but applied to a large number of species they do not seem sufficiently constant to be the basis of genera.

Of the few southeastern Polynesian species of this group, only three were collected by the Mangarevan Expedition. Of these, one is an old species first described as an *Oldenlandia*; another was one of the original species of *Kadua* and was later made one of the original species of *Gouldia,* with which, however, it has no close relationship; and the third species was recently described as a *Kadua.*

Hedyotis foetida (Forst.) Spreng.: Pug. Prodr., **2**:28, 1815.

Oldenlandia foetida Forst.: no. 55 in Fl. Ins. Austr. Prodr., 10, 1786.

Kadua rurutensis F. Brown: B. P. Bishop Mus., Bull. **130**:286, 1935.

Austral Islands. Rurutu: Mato Tea, alt. 3 m., Aug. 29, 1934, *St. John 16714;* hills northwest of Moerai, alt. 75 m., Aug. 24, 1934, *St. John and Fosberg 16565.*

The type of Brown's *Kadua rurutensis* in the Bishop Museum herbarium matches very well material from Tonga, the type locality of *Hedyotis foetida,* as do the specimens cited above.

Hedyotis romanzoffiensis (Cham. and Schlect.) Fosberg, n. comb. (fig. 1).

Kadua romanzoffiensis Cham. and Schlect.: Linnaea, 4:162, 1829.

Petesia carnosa Hook. and Arn.: Bot. Beechey's Voy., 64, 1832.

Gouldia romanzoffiensis (Cham. and Schlect.) Gray: Am. Acad., Proc., 4:310, 1860.

Coprosma oceanica W. R. B. Oliver: B. P. Bishop Mus., Bull. 132:142, 1935.

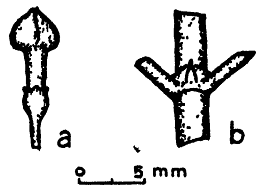

FIGURE 1.—*Hedyotis romanzoffiensis: a,* bud; *b,* node with stipules.

Erect, glabrous herb or small shrub less than 1 m. tall, internodes rather short; leaves obovate with rounded apex and cuneate base, stiff, fleshy, 1.5 mm. thick, rather glossy above, glabrous, veins somewhat pellucid; stipules broadly triangular, obtuse, mucronate, carinate, adnate with petioles into a short sheath, persistent, usually falling with the leaves; inflorescence ordinarily a terminal 3-flowered cyme, with a leaf-like bract subtending each lateral flower, a pair of such bracts part way up on the pedicel of the terminal flower, represented on the lateral pedicels by a pair of tiny pyramidal bractlets less than 1 mm. long, which sometimes replace the bracts on terminal ones, the cymes in fruit often pendent, usually appearing to be in a fork of a branch, as two branches appear at the base of the cyme; buds with the lower portion tubular, the upper part abruptly larger, broadly ovoid, 4-sided, the lobes of the corolla valvate with the outer parts slightly separate, leaving a shallow cleft, the inner part truly valvate; hypanthium broadly turbinate, round to strongly flattened, 3 mm. long, 3 mm. wide, calyx lobes obtuse, less than 1 mm. long, 1 mm. broad; flowers not dimorphic; corolla pale green, fleshy-coriaceous, tube 5 mm. long, 2 mm. wide at base, 2.5 mm. wide at throat, salverform, but without a sharp angle between the lobes and throat, lobes 4-5 mm. long, ovate, 2.5 mm. wide at base, acute, with only a slight prominence in place of an appendage outside of the apex, but with a blunt, backward pointing appendage about 0.5 mm. long on the inside of the apex, corolla readily deciduous; anthers attached in throat, narrowly sagittate, about 1.5 mm. long, with slight sterile appendage at the apex; ovary 2-celled, style 2.5 mm. long, stigma 1.5 mm. long, with 2 thickened, narrowly ovate lobes, appearing revolute around the margins, connivent and difficult to separate, style deciduous with the corolla; fruit soft and fleshy with thick aerogenous tissue, spherical or subspherical with flattened apex, the whole about 2 cm. in diameter, disk depressed and somewhat wrinkled and twisted, calyx only evident as a low, remotely denticulate ring, flesh white, epidermis white to deep purple, usually purplish on one side, endocarp lightly sclerified, cells 3-4 mm. across, fruit persistent on plant, gradually drying and becoming shriveled and obovoid, dehiscing loculicidally across the

disk when almost dry; seeds angular, irregular, peltately attached, black and loose in the ripe fruit.

The above description was made from living plants collected on Tepoto, Tuamotu Archipelago, and may be supplemented with the following, added from other specimens:

Cyme occasionally reduced to one terminal flower, solitary flowers also occasionally borne in the axils of the upper leaves; placenta fleshy, attached to the middle of the septum; loculicidal dehiscence usually followed by a slight septicidal dehiscence, making the disk open up into a small roundish hole; pedicels 1-5 cm. long, usually short in flower, elongate in fruit.

Tuamotu Archipelago: Hao, Boring Bay, alt. 1 m., May 18, 1934, *St. John 14363;* Anaa, Tukuhora, May 13, 1934, *St. John 14249, 14308;* Tepoto, alt. 1 m., May 16, 1934, *St. John 14351;* South Marutea, northwest islet, alt. 1 m., May 22, 1934, *St. John 14436, St. John and Wight 14429.*

Mangareva (Gambier) Islands: Vaiatekeua, alt. 2 m., June 6, 1934, *Fosberg 11162.*

Timoe Island, north islet, alt. 2 m., June 25, 1934, *St. John and Fosberg 15206.*

Oeno Island, June 23, 1934, *St. John and Fosberg 15192, 15198, 15200.*

Austral Islands: Raivavae, Motu Tehau, alt. 1 m., Aug. 11, 1934, *St. John and Wight 16136;* Maria, Middle Islet, alt. 2 m., Sept. 6, 1934, *Fosberg 12094, 12093;* Maria, Northeast Islet, alt. 1 m., Sept. 6, 1934, *St. John 16950.*

Pacific Equatorial Islands: Christmas Island, 4 miles west (?) of Manulu Lagoon, Oct. 21, 1934, *St. John and Fosberg 17491.*

This species has been variously treated by different authors, one of whom has even placed it in *Coprosma.* It certainly does not belong with the *Gouldia* of the Hawaiian islands. I have had some doubts as to whether or not it should constitute a new genus, but most of the characteristics that would make it seem out of place in *Hedyotis, sensu lata,* are just such differences as one would expect in a strand plant. The fleshy mesocarp, large fruit, and peculiar inflorescence would make it constitute at least a new subgenus, but until further study of the other subgenera is completed, this is as well left undone.

Three collections, two from the Danger (Pukapuka) Islands, *E. H. Bryan 13,* and *E. Beaglehole 50,* and one from Maria, *Fosberg 12093,* have longer petioles than usual, and the leaves oblanceolate

obtuse to acute. These characters seem almost sufficiently distinct to merit a name, but since the Maria Island plant was growing in the shade with normal plants in the sun nearby, it is probably only a shade form, so I will not describe it.

A widely distributed strand plant found on the coral islands throughout eastern and central Polynesia as far north as Christmas Island and at least as far west as the Danger Islands.

Native names: *koporoporo* on Hao and Anaa; *koporapora* on Tepoto; and *ti riga* on Mangareva.

Hedyotis rapensis (F. Brown) Fosberg, n. comb.

Kadua rapensis F. Brown: B. P. Bishop Mus., Bull. **130**:283, 1935.

Brown's description may be emended and corrected on the basis of further collections as follows:

The leaves vary from narrowly lanceolate or oblanceolate to narrowly obovate; stipules not connate, but adnate to the upper surface of the base of the petiole, forming the sheath in this way; also they are deciduous somewhat before the leaves; flowers in 3-flowered cymes, both terminal and axillary, the pedicel varying in length from very short to 2 cm. long; capsule sclerified, rather than coriaceous.

Two varieties may be distinguished:

Hedyotis rapensis (F. Brown) Fosberg var. **typica** Fosberg, n. nom.

This is the ordinary form originally described by Brown.

Rapa: Maitua, cliffs of Tautautu, alt. 210 m., July 11, 1934, *Fosberg 11488;* Hiri, alt. 2 m., July 27, 1934, *Fosberg 11631;* Karapo Rahi Islet, alt. 75 m., July 18, 1934, *St. John and Maireau 15598;* east side of peak between Ahurei Bay and Atanui Valley, alt. 110 m., July 3, 1934, *Fosberg 11370, 11371;* Area, alt. 20 m., July 3, 1934, *St. John and Maireau 15342;* Toutore, west of Mount Vaitau, alt. 250 m., July 6, 1934, *St. John and Maireau 15415.*

Hedyotis rapensis (F. Brown) Fosberg var. **taverana** Fosberg, n. var.

Folia cuneati-obovata obtusa, lobi calycorum oblongi-ovati obtusi.

Differs from var. *typica* in the rather fleshy branchlets, obovate-cuneate, obtuse, venulose leaves and oblong-ovate, obtuse calyx lobes.

Rapa: Tavera Valley, alt. 200 m., July 28, 1934, *St. John and Fosberg 15726* (type).

OPHIORRHIZA

Ophiorrhiza sp.

Society Islands: Tahiti, south ridge of Orofena, near top of ridge, alt. 1,700 m., Sept. 22, 1934, *St. John and Fosberg 17011.*

This specimen does not seem to fit any of the known species of *Ophiorrhiza* from Tahiti, but certainly belongs in this genus. It is only in bud and considering the complexity of the genus, I think it inadvisable to describe it without more material.

The somewhat persistent stipules keep it out of *O. subumbellata* and *O. scorpioidea*. It also has a shorter cyme than *O. scorpioidea,* and a more robust cyme and stem than *O. subumbellata.* Glabrous buds, leaves, and inflorescence, and smaller entire stipules distinguish it from *O. Nelsoni.* Much smaller, triangular, non-forked stipules, smaller leaves, and a much shorter cyme distinguish it from *O. tahitensis.* It might be *O. torrentium* Nad., but that has triflorous rather than multiflorous cymes.

The specimen comes from a higher altitude than previously recorded for this genus in Tahiti. It most nearly resembles a specimen collected in the same general locality but at 1,550 m. altitude by L. H. MacDaniels (*no. 1485*) and labeled *O. Nelsoni* by M. L. Grant. The latter specimen is somewhat pubescent and has larger, longer, aristate stipules. It also is only in bud.

PENTAS

Pentas lanceolata (Forsk.) K. Schum.: in Engl. and Prantl, Nat. Pflanzenf., Teil 4, Abt. 4, p. 29, 1891.

Ophiorrhiza lanceolata Forsk.: Fl. Aeg.-Arab., 42, 1775.

Pentas carnea Benth.: Bot. Mag., **70.** pl. 4086, 1844.

Mangareva (Gambier) Islands: Mangareva, Rikitea, alt. 3 m., May 26, 1934, *Fosberg 11021.*

NEONAUCLEA

Neonauclea Forsteri (Seem.) Merrill: Wash. Acad. Sci., Proc., **5**:540, 1915.

Nauclea Forsteri Seem.: Fl. Vit., 121, 1866.

Society Islands: Huahine, Huahine Iti, Haapu Bay, Paore, alt. 300 m., Oct. 2, 1934, *St. John 17188;* Tahaa, Haamene Bay, Oct. 10, 1934, *St. John and D. Anderson 17333;* Tahaa, east side of Mount

Purauti, alt. 175 m., Oct. 10, 1934, *St. John 17347*; Borabora, west ridge of Mount Pahio, alt. 175 m., Oct. 13, 1934, Fosberg *12157*.

Found usually on dry ridges and in rather dry forests at comparatively low altitudes.

Merrill, in the publication cited above, gives adequate reasons for using the name *Neonauclea,* rather than *Nauclea,* for this plant.

TARENNA

Tarenna sambucina (Forst.) Durand: in Drake, Ill. Fl. Ins. Mar. Pac., **6**:190, 1890.

Coffea sambucina Forst.: no. 92 in Fl. Ins. Austr. Prodr., 16, 1786.

Stylocoryne sambucina (Forst.) Gray: Am. Acad., Proc., **4**:309, 1860.

Chomelia sambucina (Forst.) O. Kuntze: Rev. Gen. Pl., **1**:278, 1891.

Tuamotu Archipelago: Anaa, Tukuhora, May 13, 1934, *St. John 14254*.

Austral Islands: Rurutu, first gulch south of Teti, west side of Teape, near head of gulch, alt. 310 m., Aug. 31, 1934, *St. John 16748*.

Society Islands: Tahaa, east side of Mount Purauti, alt. 200 m., Oct. 10, 1934, *St. John 17340;* Huahine, Huahine Nui, north ridge of Mount Matoereere, alt. 400 m., Oct. 1, 1934, *St. John 17177*.

This is the *Stylocoryne racemosa* of Hooker and Arnott (Bot. Beechey's Voy., 64, 1832), not of Cavanilles.

I do not understand Schumann's use of the name *Chomelia* for this genus. Although *Tarenna* was published subsequently to *Chomelia,* the former is invalidated by *Chomelia* Jacq. (1760), the first use of the name after 1753. *Chomelia* L. was published in Genera Plantarum (Ed. I, 1737).

Native name: *mahora* on Anaa.

GARDENIA

Gardenia tahitensis DC.: DC. Prodr., **4**:380, 1830.

Tuamotu Archipelago: Hao, Boring Bay, alt. 1 m., May 19, 1934, *St. John 14396;* Anaa, Oto Pipi, alt. 2 m., May 13, 1934, *St. John 14276*.

Mangareva (Gambier) Islands: Mangareva, Rikitea, alt. 3 m., May 31, 1934, *Fosberg 11070*.

Austral Islands: Raivavae, Mahanatoa, alt. 2 m., Aug. 6, 1934, *Fosberg 11652,* and south side of Pic Rouge, alt. 2 m., Aug. 5, 1934, *St. John and Fosberg 15919;* Tubuai, Mataura, alt. 1 m., Aug. 16, 1934, *Fosberg 11806;* Rurutu, Puputa Valley, west of Moerai, alt. 20 m., Aug. 26, 1934, *Fosberg 11867,* and Moerai, Aug. 29, 1934, *Fosberg 11968;* Rimatara, Anapoto, alt. 3 m., Sept. 4, 1934, *St. John and Fosberg 16788.*

This species is the most popular cultivated ornamental among the inhabitants of the warmer Polynesian islands. It has obviously been carried about from island to island, even in ancient times. It is probably not indigenous to southeastern Polynesia as it is not known in the wild state there. It is usually known by the Tahitian name, *tiare tahiti.*

Gardenia jasminoides Ellis: Phil. Trans., **51**:935, 1761.

Mangareva (Gambier) Islands: Mangareva, Point Teone Kura, alt. 2 m., June 5, 1934, *Fosberg 11121.*

Pitcairn Island, Adamstown, alt. 65 m., June 14, 1934, *Fosberg 11249.*

Rapa, Ahurei, alt. 4 m., July 23, 1934, *St. John and Maireau 15706.*

Austral Islands: Raivavae, lower R. Arepua, alt. 5 m., Aug. 6, 1934, *Fosberg 11644;* Tubuai, Tamatoa, alt. 2 m., Aug. 23, 1934, *Fosberg and A. Anderson 11846;* Rimatara, Amaru, alt. 3 m., Sept. 5, 1934, *St. John 16931.*

This species, the common cultivated gardenia, has become widely cultivated in Polynesia since the advent of the Europeans.

CANTHIUM

Canthium is widespread in Polynesia but is represented by few species, mere outliers apparently, of the large numbers occurring in the continental and large insular areas farther west. In southeastern Polynesia only two species are present, both occurring on almost all the volcanic and raised coral islands. They seem to occur in dry to moist forests from practically sea level up to middle altitudes in the highest islands, and up to the summits of the smaller ones.

Canthium odoratum (Forst.) Seem.: Fl. Vit., 132, 1866.

Coffea odorata Forst.: no. 94 in Fl. Ins. Austr. Prodr., 16, 1786.

Canthium lucidum Hook. and Arn.: Bot. Beechey's Voy., 65, 1832 (not of R. Br. or Schlect.).

Canthium Beecheyi Steud.: Nom. Bot., Ed. II, 1:275, 1841.

Plectronia odorata (Forst.) Benth. and Hook., in Hillebr., Fl. Haw. Is., 175, 1888.

Plectronia kohenua F. Brown: B. P. Bishop Mus., Bull. **130**:297, 1935.

Mangareva (Gambier) Islands: Mangareva, south side of Mount Mokoto, alt. 340 m., June 7, 1934, *St. John 14902;* same locality, alt. 320 m., June 2, 1934, *St. John 14855;* Aukena, Koiovao, alt. 10 m., May 29, 1934, *St. John 14666.*

Pitcairn Island: Parlver Valley Ridge, alt. 330 m., June 13, 1934, *St. John 14961;* Flatlands, alt. 120 m., June 13, 1934, *Fosberg and Christian 11232;* valley back of Adamstown, alt. 175 m, June 13, 1934, *St. John 14950.*

Henderson Island. north end, alt. 30 m., June 17, 1934, *St. John and Fosberg 15072, 15073, 15075,* north center, alt. 30 m., June 20, 1934, *St. John and Fosberg 15176.*

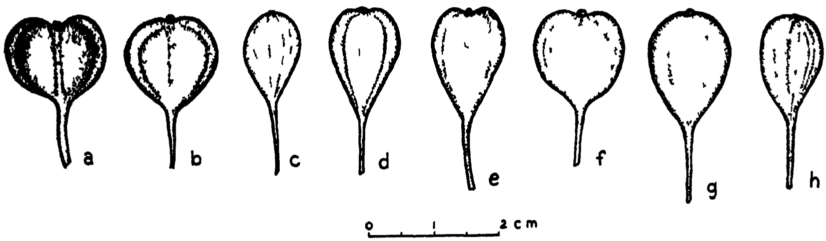

FIGURE 2—Fruits of varieties of *Canthium barbatum* *a,* var *rapae, b,* var. *gambierense, c,* var *huahinense, d,* var *australense* f. *rurutu, e,* var *australense* f *tubuai, f,* var *societense, g,* var *Christianii* f *pitcairnense, h,* var *Christianii* f *calcicola*

Rapa: Mount Vaitau, alt. 240 m., July 8, 1934, *St. John and Zimmerman 15424;* Area, alt. 150 m., July 2, 1934, *St. John and Fosberg 15318;* same locality, July 1, 1934, *St. John and Fosberg 15278, 15288;* Anarua Valley, southeast ridge of Mount Perahu, alt. 300 m., July 12, 1934, *Fosberg 11506;* Pupu Point, alt. 3 m., July 15, 1934, *Fosberg 11532, 11534.*

Austral Islands: Rurutu, west slope of Mato Arei, alt. 40 m., *St. John 16708;* Raivavae, northwest slope of Pic Rouge, Aug. 5, 1934, *St. John and Fosberg 15959.*

Society Islands: Tahaa, east ridge of Mount Purauti, alt. 500 m., Oct. 11, 1934, *St. John 17395.*

Plectronia kohenua F. Brown is apparently the exact equivalent of *Canthium odoratum.* Brown compared his specimens with material from Hawaii which varies tremendously in many characters, including those pointed out by him as different. Furthermore, if the Hawaiian plant differs from that of southeastern Polynesia, it is the Hawaiian form that must be considered new, as the type locality of *Coffea odorata* Forst. is Tahiti. There seems to be as much variation in this plant on the same island as between the various islands on which it was collected. Some of the Rapa specimens would, if taken by themselves, seem to form a distinct, small-leafed variety, but other specimens from the same island have larger leaves, some about as large as those from the islands farther north and east.

Practically all the leaf sizes and shapes in the collections from southeastern Polynesia can be duplicated in the Hawaiian collections available. The flowers of the southeastern Polynesian material are a trifle smaller than most of those from Hawaii but not significantly so. In his comparison, Brown states "flowers glabrate in the throat", but in his description, they are "bearded or glabrate." The size and shape of the fruit varies on individual specimens as much as between Brown's varieties and as much as between his specimens and the Hawaiian ones. I do not understand his statement that the inner wall of the seed cavity is arched inward only slightly; in any case the fruits of his type specimens and of Hawaiian specimens are identical in structure.

From the above data I would conclude that either this species is a comparatively recent arrival in Polynesia, or that the variation is largely the result of environment rather than of heredity. The wide distribution of the species counts heavily against the first of these possibilities. If the variation were genetic, long isolation would surely have produced definite local varieties or species as it has with many other plants, including the other species of *Canthium* here to be discussed.

Canthium barbatum (Forst.) Seem.: Fl. Vit., 132, 1866 (figs. 2, 3.)
Chiococca barbata Forst.: no. 96 in Fl. Ins. Austr. Prodr., 16, 1786.
Plectronia barbata (Forst.) K. Schum.: in Engl. and Prantl, Nat. Pflanzenf., Teil 4, Abt. 4, p. 92, 1891.

The variation in this species differs somewhat from that in *C. odoratum.* Either it has been longer in Polynesia, which its distribution

does not bear out, or its variations have had more evolutionary value, as a different form appears on every isolated island or group of islands in at least the eastern part of its range.

Plectronia rapae Riley, when described, was apparently distinct enough, characterized by large, obtuse leaves with pellucid veins, ciliolate corolla lobes and calyx lobes. With the collections now available, however, it would have to include material from the Austral Islands, Mangareva, Pitcairn, and Henderson. With these included, its only distinguishing characters would be the ciliolate calyx and corolla, with the material from Rurutu and Mangareva closely approaching typical *C. barbatum* from Tahiti.

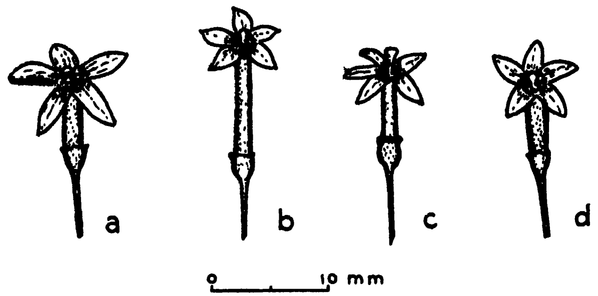

FIGURE 3.—Flowers of varieties of *Canthium barbatum: a,* var. *rapae; b,* var. *raivavaense; c,* var. *australense* f. *tubuai; d,* var. *australense* f. *rurutu.*

The varieties and forms here recognized may, I think, be considered incipient species which have not had time to differentiate sufficiently to justify their ranking as species. No attempt has been made in this paper to dispose of the various forms of the species which occur on islands not visited by the Mangarevan Expedition, extending from the Marquesas at least to Fiji and Tonga. Three original localities were given by Forster with no indication that the plants from each differed in any respect. His plants came from the Marquesas, Tahiti, and Tonga. I consider that a different variety occurs in each of these three places. All three will eventually have to have varietal names, but only one of these will be given here. The first of the following varieties includes all the material which I have seen from Tahiti, and though I have not seen Forster's specimens, undoubtedly forms a part of the original *Chiococca barbata*.

Canthium barbatum (Forst.) Seem. var. **societense** Fosberg, n. var. (fig. 2, *f*).

Chiococca barbata Forst.: no. 96 in Fl. Ins. Austr. Prodr., 16, 1786 (in part).

Folia ovata vel elliptica valde acuminata, nervi non pellucidi, cyma 3-6-florifera, calyx et corolla non ciliolata, drupa pyriformis-obcordata.

Small tree; branchlets glabrous, terete, or when young somewhat 4-sided, internodes ordinarily 4-5 cm. long; leaves 8-13 cm. long (ordinarily 9-10 cm.), 4-6 cm. wide (ordinarily about 4.5 cm.), glabrous, ovate to elliptical, rarely oblong, apex pronouncedly acuminate, base obtuse but attenuate to a petiole less than 1 cm. long, blade chartaceous, veins not pellucid; stipules triangular, somewhat mucronate, early deciduous; cymes small, 3-6-flowered (usually 6, though some flowers often fall early), axillary, peduncles 2-10 mm. long, pedicels, in flower, 5-8 mm. long, in fruit up to 18 mm. long; ovary + calyx 2 mm. long, calyx glabrous, 5-dentate, teeth obtuse to acute, short; corolla tube 4-6 mm. long, 1-1.5 mm. thick, strongly bearded in the throat, lobes 3.5 mm. long, ovate-lanceolate, mucronate, glabrous; fruit 10-12 mm. long, 12-15 mm. wide, broadly pyriform, somewhat flattened and obcordate when both cells are developed, flesh soft, of a deep flesh-red color when ripe, the fleshy-fibrous base attenuating into the pedicel, pyrenes heavily sclerified, rather firmly grown together.

Society Islands. Tahaa: islet in Haamene Bay, alt. 8 m., Oct. 10, 1934, *Fosberg and Cooke 12141* (type); east side of Mount Purauti, alt. 15 m., Oct. 10, 1934, *St. John 17380*; same locality and date, alt. 230 m., *St. John 17363*. Raiatea: Uturoa, alt. 300 m., Sept. 10, 1926, *Moore 58*; without locality, alt. 300 m., Sept. 26, 1926, *Moore 148*. Tahiti: Paea, Nov. 10, 1902, *Seale*; Papenoo Valley, alt. 50 m., Oct. 22, 1928, *Adamson 22*; Papehue, Paea, June 1910, *Tilden 355*; Papieri, alt. 100 ft., March 20, 1925, *Wilder 322*; Papara District, alt. 50 ft., Dec. 4, 1926, *Wilder 532*; without locality, June 21, 1922, *Setchell and Parks 412*; without locality, May 23, 1922, *Setchell and Parks 81*.

Among the Tahitian specimens examined, two vague forms may be distinguished on the basis of the length of the peduncle, but as the collections are few and the differences slight, they probably amount to nothing. The Raiatea and Tahaa specimens differ slightly from most of the Tahitian material in that the peduncles are all less than 5 mm. long and the fruiting pedicels are heavier and straighter, less than 12 mm. long, usually 10 mm. or less.

Canthium barbatum (Forst.) Seem. var. **huahinense** Fosberg, n. var. (fig. 2, *c*).

Ramuli graciles, internodi 1.5-3.5 cm. longi, folia 6-8 cm. longa 3-4 cm. lata elliptica, drupa 7-10 mm. lata saepe 3-locularis.

A slender shrub, resembling var. *societense* but branchlets noticeably more slender, internodes usually 1.5-3.5 cm. long; leaves mostly smaller, 6-8 cm. long,

3-4 cm. wide, definitely tending toward an elliptical outline; pedicels more slender; fruit much narrower, 7-10 mm. wide, only slightly emarginate at apex, often 3-celled.

Society Islands. Huahine: Huahine Iti, Haapu, north side of bay, alt. 15 m., Oct. 3, 1934, *Fosberg 12131* (type), *12132*; Huahine Iti, Paore, Haapu Bay, alt. 300 m., Oct. 2, 1934, *St. John 17184.*

Though this is close to var. *societense,* it also resembles var. *raiateense* in its short internodes and small elliptical leaves (these characters being more marked in the latter variety, however), but the exact relationship here cannot be determined, as the type of var. *raiateense* lacks fruit, and the available material of var. *huahinense* lacks flowers.

Canthium barbatum (Forst.) Seem. var. **raiateense** (Moore) Fosberg, n. comb.

Plectronia raiateensis J. W. Moore: B. P. Bishop Mus., Bull. **122**: 45, 1933.

This plant is too closely related to var. *societense* and to var. *huahinense* to be maintained as a species. The glands on the pedicel and hypanthium are sometimes present, though not so abundantly, on other varieties. The long flowers, small elliptical leaves and slender habit are only such characters as I have used to distinguish between other varieties in this species.

Canthium barbatum (Forst.) Seem. var. **temehaniense** (Moore) Fosberg, n. comb.

Plectronia temehaniensis J. W. Moore: B. P. Bishop Mus., Bull. **102**: 45, 1933.

This plant is also too close to *C. barbatum* to be considered a species. Apparently nothing separates it from var. *societense* excepting the subcordate, almost sessile leaves, which suggest some of the Marquesan forms. The specimen of the type collection at Bishop Museum is so incomplete that I would hesitate to state definitely to what varieties it is most similar.

Canthium barbatum (Forst.) Seem. var. **australense** Fosberg, n. var.

Nervi foliarum pellucidi, pedunculi breves, calyx et corolla minute ciliolata, tuba corollae 4-5 mm. longa, stigma exserta, fructus 15 mm. longus 11 mm. latus non emarginatus.

Differing from var. *societense* in the square branchlets, short, acuminate to obtuse leaves with pellucid veins; peduncle condensed to a mere corky lump bearing several old pedicel scars as well as pedicels; calyx lobes short, obtuse, ciliolate; corolla tube 4-5 mm. long, corolla lobes ciliolate, not mucronate; stigma exserted 1-2 mm.; fruit 15 mm. long, 11 mm. wide, not emarginate.

The type is *St. John 16362* from Tubuai.

This variety occurs in the Austral Islands on the islands of Rurutu and Tubuai, with a distinct form on each. It is related to var. *rapae,* as shown by the pellucid veins and ciliolate calyx and corolla, but the form on Rurutu shows a decided approach, also, to var. *societense.* It differs from both of these in the long, narrow fruits and more reduced cymes, and from var. *societense* also in the pellucid veins and the ciliolate calyx and corolla.

Canthium barbatum (Forst.) Seem. var. **australense** Fosberg f. **tubuai** Fosberg, n. f. (figs. 2, *e*; 3, *c*).

Folia magna 10-12 cm. longa, 6-7 cm. lata elliptica vel obovata, pedicilus 7-12 mm. longus, loba corollae 4 mm. longa.

Leaves ordinarily 10-12 cm. long, 6-7 cm. wide, broadly elliptical to obovate, obtuse to slightly acuminate, petiole about 1 cm. long; flowering pedicel 7-8 mm. long, fruiting pedicel 11-12 mm. long; corolla lobes 4 mm. long.

Austral Islands: Tubuai, northeast slope of Taitaa, alt. 340 m., Aug. 16, 1934, *St. John 16362* (type).

Canthium barbatum (Forst.) Seem. var. **australense** Fosberg f. **rurutu** Fosberg, n. f. (figs. 2, *d*; 3, *d*).

Folia acuminata, pedicilus 5-7 mm. longus, lobae corollae 3 mm. longae.

Leaves up to 9 cm. long, 4.5 cm. wide, petiole 0.5 cm. long; flowering pedicel 5 mm. long, fruiting pedicel 7 mm. long; corolla lobes 3 mm. long.

Austral Islands: Rurutu, Mato Tea, alt. 100 m., Sept. 1, 1934, *St. John and D. Anderson 16785* (type).

Canthium barbatum (Forst.) Seem. var. **raivavaense** Fosberg, n. var. (fig. 3, *b*).

Nervi foliarum pellucidi; pedicilus floriferis 2-5 mm. longus deinde fructibus maxime 11 mm. longae; tuba corollae 6-7 mm. longa, lobae corollae 3-4 mm. longae.

Like var. *australense* f. *tubuai* but branchlets not markedly 4-sided, internodes variable but tend to be shorter; cymes up to 6 mm. long (without pedicels), branched, bearing up to 10 flowers and numerous scars; flowering pedicels 2-5 mm. long, fruiting pedicels up to 11 cm. long; corolla tube 6-7 mm. long, lobes 3-4 mm. long; ripe fruit not available.

Austral Islands. Raivavae: south side of Pic Rouge, alt. 75 m., Aug. 5, 1934, *St. John and Fosberg 15931* (type); R. Arepua, alt. 20 m., Aug. 5, 1934, *St. John and Cooke 15890*; south side of pass south of Raiurua, alt. 75 m., Aug. 3, 1934, *St. John and Fosberg 15816.*

Canthium barbatum (Forst.) Seem. var. **rapae** (Riley) Fosberg, n. comb. (figs. 2, *a*, 3, *a*).

Plectronia rapae Riley: Kew Bull., 54, 1926.

Plectronia rapae Riley, of F. Brown: B. P. Bishop Mus., Bull. **130**:296, 1935 (in part).

Folia ovata obtusa ad basim attenuata, tuba corollae 4-5 mm. longa, lobae corollae 4-5 mm. longae, fructus 10-12 mm. longus 13-15 mm. latus emarginatus.

Like var. *raivavaense* but leaves conspicuously blunt-obtuse, somewhat smaller, conspicuously attenuate at base, variable in size, tending to be ovate, drying bluish; cymes not so well developed, but more so than in var. *australense*, flowering pedicels 6 mm. long, fruiting pedicels 10-14 mm. long; corolla tube 4-5 mm. long, lobes 4-5 mm. long; fruit 10-12 mm. long, 13-15 mm. wide, noticeably emarginate.

Rapa: Watering Place, near Area, alt. 15 m., June 30, 1934, *St. John and Fosberg 15239*; Anarua Valley, southeast ridge of Mount Perahu, alt. 300 m., July 12, 1934, *Fosberg 11519*; east slope of ridge between Morongota and Vaitau, alt. 150 m., July 20, 1934, *Fosberg 11611*; Oromanga forest, south side of Tangikeu Mountain, alt. 150 m., July 11, 1934, *St. John and Maireau 15483*; Area, alt. 90 m., July 3, 1934, *St. John and Maireau 15350*; Oroi, Angairau Bay, alt. 125 m., July 9, 1934, *St. John and Maireau 15455*.

Canthium barbatum (Forst.) Seem. var. **Christianii** Fosberg, n. var.

Venes foliarum pellucides, fructus 14-16 mm. longus, 10-12 mm. latus exemarginatus.

Like var. *rapae* but leaves tending to be slightly acuminate at apex, somewhat more abruptly contracted at base; cyme slightly more condensed, flowering pedicels 3-5 mm. long; fruits 14-16 mm. long, 10-12 mm. wide, very slightly, if at all, emarginate.

This variety includes two forms which are usually distinguishable and which have separate geographic ranges. It is named for Mr. Burnett Christian, my companion while collecting on Pitcairn Island, who scaled a cliff to obtain the type collection.

It is incorrectly referred to *Plectronia rapae* Riley by F. Brown (B. P. Bishop Mus., Bull. **130**:269, 1935).

Canthium barbatum (Forst.) Seem. var. **Christianii** Fosberg f. **pitcairnense** Fosberg, n. f. (fig. 2, *g*).

Fructus bilocularis.
Fruit always 2-celled.

Pitcairn Island: Flatlands, alt. 100 m., June 13, 1934, *Fosberg and Christian 11235* (type of variety and form).

Canthium barbatum (Forst.) Seem. var. **Christianii** Fosberg f. **calcicola** Fosberg, n. f. (fig. 2, *h*).

Fructus saepe trilocularis.
Fruit tending to be 3-celled.

Henderson Island: north end, alt. 25 m., June 17, 1934, *St. John and Fosberg 15085* (type); same locality and date, alt. 30 m., *St. John and Fosberg 15115.*

Incorrectly referred to *Chiococca odorata* Forst. by Hooker and Arnott (Bot. Beechey's Voy., 65, 1832). The name refers to its habitat, the coral limestone which makes up Henderson Island.

Canthium barbatum (Forst.) Seem. var. **gambierense** Fosberg, n. var. (fig. 2, *b*).

Nerves foliarum pellucides, folia elliptica acuminata, pedunculus 1-2 mm. longus 3-4 floriferus, fructus pauce emarginatus.

Like var. *societense* but leaves elliptical, with apex not so long acuminate but more abruptly so, longer attenuate at base, veins somewhat pellucid; cymes reduced to a peduncle 1-2 mm. long, out of the top of which arise 3 or 4 pedicels, each surrounded by a definite collar at the base, pedicels in fruit 12-18 mm. long; fruit only very slightly emarginate; flowers unknown.

Mangareva (Gambier) Islands: Mangareva, south side of Mount Mokoto, alt. 290 m., June 4, 1934, *St. John 14871* (type); same locality and date, alt. 320 m., *St. John 14878*; same locality, alt. 340 m., June 7, 1934, *St. John 14905*; same locality, alt. 350 m., June 3, 1934, *St. John and D. Anderson 14866.*

This variety forms a connecting link between the group of varieties centering around var. *societense* and that extending from Rurutu to Henderson Island. Its pellucid veins relate it to the latter group, while most of its other known characters resemble the former. When flowering specimens are collected, it will probably be possible to place it exactly by the presence or absence of ciliolation on the corolla lobes.

GUETTARDA

Guettarda speciosa L.: Species Plantarum, 991, 1753.

Tuamotu Archipelago: Tepoto, May 16, 1934, *St. John 14344*; Anaa, Tukuhara, May 13, 1934, *St. John 14290*; Hao, Boring Bay, May 18, 1934, *St. John 14354*; South Marutea, northwest island, May 22, 1934, *St. John 14446.*

Mangareva (Gambier) Islands: Vaiatekeua, June 6, 1934, *Fosberg 11148* (near a shack, possibly planted by former inhabitants).

Timoe Island, north islet, June 25, 1934, *St. John and Fosberg 15226.*

Pitcairn Island, St. Pauls Valley, alt. 220 m., June 14, 1934, *St. John 15009.*

Henderson Island: north end, alt. 15 m., June 17, 1934, *St. John and Fosberg 15081*; north center, June 20, 1934, *St. John and Fosberg 15165.*

Austral Islands: Raivavae, Motu Tehau, Aug. 11, 1934, *St. John and Wight 16135*; Tubuai, Tapapatauai Islet, Aug. 19, 1934, *St. John 16424.*

Native names: Tuamotu Archipelago, on Tepoto, *karauri,* on Anaa and Hao, *kahaia*; on Pitcairn Island, *high white* and, by a curious misapplication, *morinda citrifolia.*

This widely distributed strand tree is, within certain limits, quite variable. The leaves vary in shape from the usual decidedly obovate type to oblong or even ovate, with the base varying from rounded or truncate to subcordate or cordate, and the apex from obtuse to acuminate, sometimes decidedly so. I have seen specimens from other parts of the range of this species exhibiting strange and widely different leaf shapes. The vesture of the leaves varies from almost glabrous to hirsute on the under side of the veins, and on the veinlets from puberulent to so pubescent that the under side of the leaf seems velutinous.

With respect to southeastern Polynesia, only one of these variations has been named, *Guettarda tahitensis* Nad., reduced to a variety by Drake, and here treated as a form.

Guettarda speciosa L. f. **tahitensis** (Nad.) Fosberg, n. comb.

Guettarda tahitensis Nad., no. 352 in Enum. Pl. Tahiti, 52, 1873.

Guettarda speciosa L. var. *tahitensis* (Nad.) Drake: Fl. Polyn. Fran., 92, 1893.

Differs from *G. speciosa* in the much more hirtellous-pubescent under sides of the veins and veinlets in the leaves, making the whole under surface appear sub-velutinous or velutinous.

Mangareva (Gambier) Islands: Tauna Islet, alt. 3 m., May 31, 1934, *St. John 14750.*

Austral Islands, Rurutu: Mato Naa, alt. 60 m., Aug. 24, 1934, *St. John and Fosberg 16914*; Rimatara, Anapoto, alt. 5 m., Sept. 4, 1934, *St. John and Fosberg 16914.* Maria: northeast islet, alt. 2 m., Sept. 6, 1934, *St. John 16958*; southeast islet, alt. 3 m., Sept. 6, 1934, *Fosberg*

12086; middle islet, alt. 2 m., Sept. 6, 1934, *Fosberg 12101;* southwest islet, alt. 3 m., Sept. 6, 1934, *Fosberg 12120.*

Flint Island, alt. 2 m., Oct. 16, 1934, *St. John and Fosberg 17460.*

Fanning Island, English Harbor, alt. 1 m., April 23, 1934, *St. John and Fosberg 14118* (very possibly planted by recent settlers).

This was described as a species by Nadeaud from a specimen collected by him in Tahiti. Drake reduced it to a variety, but did not extend its range, having seen only the type specimen. In the Mangarevan Expedition collections, plants corresponding to this are almost as numerous as those belonging to *G. speciosa* proper, and represent as wide a geographic range. In addition to these, the Bishop Museum herbarium possesses material referable to this form from the Marquesas, Cook Islands, Tuamotus, Society Islands (Scilly), Danger Islands, Phoenix Islands, and even a plant from the Philippines seems to belong here. This distribution indicates a complete lack of geographical unity, making the very hairy plant seem a mere sporadic variation arising independently at different times and places. If it could be demonstrated that either or both forms had been carried by the Polynesians, and were not truly indigenous to Polynesia, this conception might be altered, but no convincing evidence of this has come to my attention.

Dr. St. John examined the type of *G. tahitensis* for me while in Paris, and confirmed my suspicion that it was the same as the plant which we had collected. The actual amount of puberulence varies so much in both forms that some specimens are with difficulty placed in one or the other. These considerations lead me to reduce *G. tahitensis* to a form of *G. speciosa.* Apparently the form has not been collected in Tahiti since the original collection, though the species proper has been found there commonly enough.

TIMONIUS

Timonius polygamus (Forst.) Robinson: Am. Acad., Proc., **45**:394, 1910.

Erithalis polygama Forst.: no. 101 in Fl. Ins. Austr. Prodr., 17, 1786.

Burneya Forsteri Cham. and Schl.: Linnaea, **4**:185, 1829.

Timonius Forsteri (Cham. and Schl.) DC.: DC. Prodr., **4**:461, 1830.

Tuamotu Archipelago: Anaa, Tukuhora, alt. 2 m., May 13, 1934, *St. John 14305;* Anaa, Ote Pipi, alt. 2 m., May 13, 1934, *St. John 14274;* Hao, Boring Bay, alt. 2 m., May 18, 1934, *St. John 14352.*

Henderson Island: north end, alt. 15 m., June 17, 1934, *St. John and Fosberg 15076, 15063, 15120;* same locality and date, alt. 1 and 2 m., *St. John and Fosberg 15094, 15082;* same locality, alt. 33 m., June 18, 1934, *St. John and Fosberg 15122, 15140;* north center, alt. 30 m., June 20, 1934, *St. John and Fosberg 15174.*

Austral Islands: Rimatara, Anapoto, alt. 5 m., Sept. 4, 1934, *St. John and Fosberg 16871, 16911;* Maria, southeast islet, alt. 2 m., Sept. 6, 1934, *Fosberg 12067;* Maria, northeast islet, alt. 2 m., Sept. 6, 1934, *St. John 16957.*

A widely distributed strand plant, growing either on raised coral limestone or sandy flats and beaches. It is most variable, either erect or prostrate, leaves from obovate to orbicular, cuneate to cordate; flower length and size of cyme various, the staminate cymes much longer.

Called *T. Forsteri* by most authors.

Native names: *katokato* on Anaa; *paketa* on Hao.

COFFEA

Coffee is one of the three agricultural crops raised for export in southeastern Polynesia. In Rapa it is the only one and the only source of income for the inhabitants. The quality produced is excellent due, it is claimed, to the fact that the fruits are allowed to ripen on the tree and to fall on the ground. Then they are harvested by gathering the seeds from the ground after the flesh is gone, thus assuring that all the beans are fully ripe when used. The stripping methods used in other countries certainly cause the harvesting of a large percentage of the fruits before they are thoroughly mature.

Coffea arabica L.: Species Plantarum, 172, 1753.

Mangareva (Gambier) Islands: Mangareva, northwest slope of Mount Duff, alt. 100 m., May 24, 1934, *St. John 14486;* Taravai, northeast end, alt. 4 m., June 1, 1934, *St. John 14765;* Akamaru, north side, alt. 3 m., May 29, 1934, *St. John 14709.*

Pitcairn Island: Adamstown, alt. 70 m., June 15, 1934, *St. John 15034.*

Rapa: valley two fifths of a mile east of Ahurei, alt. 30 m., July 1, 1934, *St. John and Fosberg 15268.*

Austral Islands: Raivavae, slope up to pass south of Raiurua, alt. 50 m., Aug. 3, 1934, *St. John and Fosberg 15854;* Tubuai, along road south of Mataura, alt. 20 m., Aug. 15, 1934, *St. John 16222;* Rurutu, Puputa Valley, west of Moerai, alt. 25 m., Aug. 26, 1934, *Fosberg 11865;* Rurutu, road southwest of Moerai, alt. 30 m., Aug. 26, 1934, *St. John 16685;* Rimatara, Anapoto, alt. 3 m., Sept. 4, 1934, *St. John and Fosberg 16893.*

Coffea liberica Hiern (?): Linn. Soc. Lond., Trans., II, 1:171, 1876.

Mangareva (Gambier) Islands: Mangareva, Rikitea, June 1, 1934, *St. John and Garwood 14840.*

The specimen is sterile so the identity is not certain, though vegetatively it looks like this species. It is said by Mr. Stephen Garwood, a resident of the island, to have grown from seeds received as "Mocha coffee."

IXORA

The native southeastern species of *Ixora* all belong to the section *Phyleilema* Gray (except possibly *I. temehaniensis* Moore), characterized by a much reduced inflorescence enclosed between two foliaceous bracts. Members of this section are found from Henderson Island and the Marquesas as far westward as New Caledonia, Queensland, and Micronesia.

They form the most critical and difficult group of Rubiaceae in southeastern Polynesia. Many different forms are found which closely resemble each other, and most of which might be placed in one species by an extremely conservative botanist. However, when subjected to close examination, a large aggregation of individually minor differences come to light, which, together with the distinct geographic ranges of most of the forms, make it seem best to consider them species pending a more thorough revision of the section. As is true with most of the other groups of endemic plants in southeastern Polynesia, a final treatment is greatly obstructed by lack of sufficient collections of most of the species. Few of them are represented in herbaria by material in enough stages of development for a full understanding.

Ixora triflora (Forst.) Seem.: Fl. Vit., 133, April 2, 1866 (fig. 4, *c*).
Not *I. triflora* R. Br.: in Benth., Fl. Austr., 3:416, Jan. 5, 1867.
Coffea triflora Forst.: no. 75 in Fl. Ins. Austr. Prodr., 16, 1786.

Shrub or tree up to 7 m. tall, stems terete, internodes rather short but variable; leaves elliptical to slightly obovate, up to 10 cm. long and 5 cm. wide, apex acuminate, base acute, slightly attenuate, petiole somewhat winged, up to

1 cm. long, usually about 5 mm. long; stipules 5-8 mm. long, ovate, connate to 1.5 mm., long acuminate, carinate; cymes terminal or more commonly on short lateral branchlets, peduncles up to 1.5 cm. long, usually less than 1 cm.; bracts ovate, up to 3.5 cm. long, usually 2 cm., up to 2.5 cm. wide, usually 1-2 cm., apex acuminate, base shortly attenuate, petiole winged, 2-5 mm. long; portion of cyme above bracts reduced to 2 or 3 tiny cymules which are each composed of 3 or 4 almost sessile flowers joined at the base, pedicels 1.5-2 mm. long, hypanthium 1 mm. long, free part of calyx 1 mm. long, teeth very short and of unequal length, corolla 4-lobed, tube 9-12 mm. long, less than 1 mm. thick, pinkish, lobes lanceolate, acuminate, 7-9 mm. long, white, sour smelling; fruit unknown.

Society Islands. Huahine: Huahine Iti, north side of Haapu Bay, alt. 50 m., Oct. 3, 1934, *St. John and Cooke 17194;* Huahine Iti, Paore, Haapu Bay, alt. 300 m., Oct. 2, 1934, *St. John 17187.*

The rediscovery of this little known species on Huahine rather than on Tahiti makes one suspect that it was originally collected on the former island, rather than on Tahiti. Both Forster narratives of Cook's voyage mention a short stop at Huahine with some botanizing. The occurrence of this plant, even at present, at as low an altitude as 50 meters makes it quite possible that they found it on the short collecting trips that were made. Certainly nothing has been found in Tahiti since that answers to a description of the type specimen.

Dr. St. John kindly examined the type of this species for me in the British Museum herbarium, and prepared a careful description and several sketches which enabled me to be sure of the determination, though Forster's original description would fit almost equally well any species in the section *Phyleilema.*

Ixora Setchellii Fosberg, n. sp. (figs. 4, *e;* 5).

Arbor vel frutex subscandens, folia sessiles vel raro subsessiles, bracteae sessiles lata ovati-cordatae acuminatae, pars cymi supra bracteas glabrus reductus, 2 vel 3 cymules 3-4 florarum ad basim adnati in pedunculis 1-5 mm. longis, tubus corollae gracilis 1.5-2.5 cm. longus, lobi lanceolati acuminati 5-7 mm. longi, antherae lineares exsertae, stigmata 2 mm. longa bifida, segmentae recurvatae.

Tree or sometimes a somewhat scandent shrub up to 10 m. tall, branchlets terete, or when very young, 4-sided, internodes ordinarily 3-5 cm. long; leaves on older growth oblong to obovate, cordate at base, decidedly acuminate at apex, up to 18 cm. long, usually 10-15 cm., up to 7 cm. wide, usually 4-6 cm., leaves nearer inflorescences gradually smaller, oblong to ovate, cordate, acuminate, all leaves sessile (1 or 2 leaves with slight petiole in Moore 509), the basal 3-8 mm. of the midrib thickened as though the cordate basal lobes had become connate with a former, short, thickened petiole; stipules 5-6 mm. long, ovate, long-acuminate; cymes terminal with peduncles 2-5 cm. long (or occasionally axillary and subsessile); bracts sessile, broadly ovate-cordate, acuminate, 2.5-4.5 cm. long, 2-4.5 cm. wide, thin; portion of cyme above bracts

reduced to a short peduncle 1-5 mm. long, branching into 2 or 3 tiny 3-4-flowered cymules, rarely subtended by tiny bracts if well developed, each cymule with a peduncle about 1 mm. long, with pedicels less than 1 mm. long, the whole glabrous, axillary ones much more reduced; hypanthium 1 mm. long, free part of calyx 0.8-1 mm. long, thin, very shortly 4-dentate, spreading; corolla tube very slender, about 0 5 mm. thick, 1.5-2.5 cm. long, lobes lanceolate acuminate, 5-7 mm. long; anthers linear, 3 mm. long, exserted; pistil exserted 2.5-3 mm., stigma 2 mm. long, bifid, the segments recurved; flower pink; fruit subglobose, red (?), size when mature not known, probably rather small.

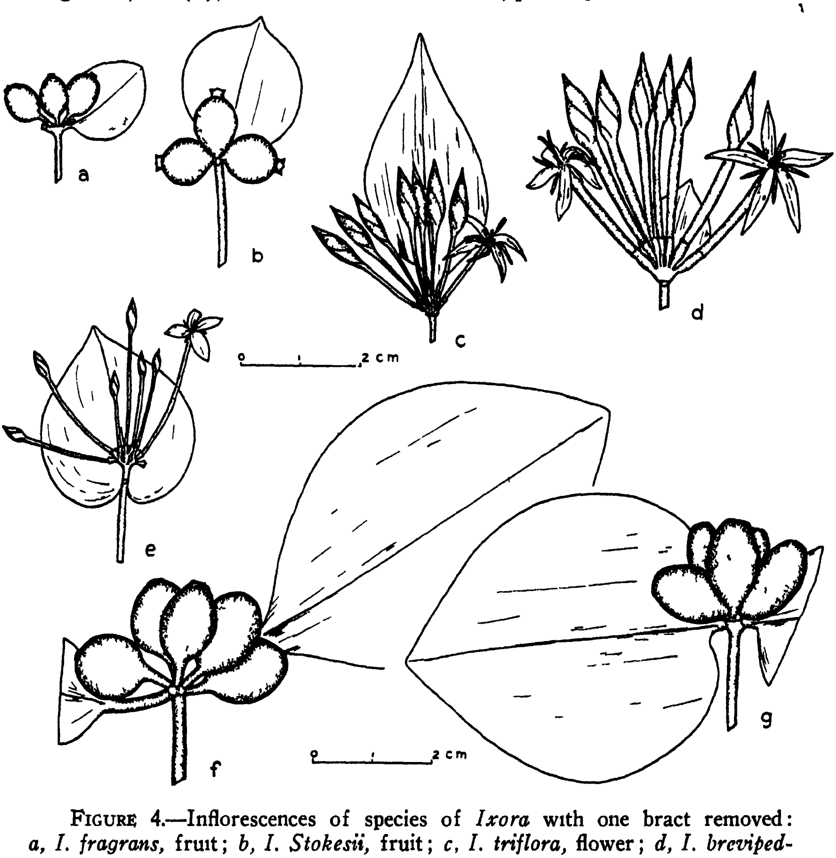

FIGURE 4.—Inflorescences of species of *Ixora* with one bract removed: *a, I. fragrans,* fruit; *b, I. Stokesii,* fruit; *c, I. triflora,* flower; *d, I. brevipedunculata,* flower; *e, I Setchellii; f, I. St-Johnii; g, I. raivavaensis.*

The following collections include all material available in the herbaria of Bishop Museum and the University of California.

Society Islands. Tahiti: Orofere Valley, Tarevareva River, alt. 2,000 ft., June 8, 1922, *Setchell and Parks 312;* same locality, June 12, 1922, *Setchell and Parks 339;* same locality, June 13, 1922, *Set-*

chell and Parks 345 (in part). Raiatea: Temihani Plateau, alt. 500 m., Oct. 5, 1934, *St. John 17244* (type), valley east side of Mount Oratorio, alt. 150 m, Oct 5, 1934, *St. John and Cooke 17239;* Avera, Temehani, alt. 1,300 ft., Jan 29, 1931, *Grant 5193,* upper part of Avera (?) Valley, alt 350 m, Jan. 11, 1927, *Moore 509.* Tahaa: east ridge of Mount Purauti, alt. 500 m, Oct. 11, 1934, *St. John 17396*; Ruutia, Mount Ohiri, alt 1,590 ft, Jan 15, 1931, *Grant 5177.*

FIGURE 5—*Ixora Setchellii*

This species is most closely related to *Ixora moorensis* (Nad.) Fosberg,[2] of Moorea from which it is distinguished by its bifid style, 2-celled ovary, and sessile leaves.

This is the species interpreted as *I. fragrans* by Setchell (Univ. Calif. Pub. Bot., **12**:211, 1926), Moore (in herb.), Grant (in herb.), and probably by both Drake and Nadeaud. However the type locality of *I. fragrans* is Henderson Island, and it is now represented in herbaria by a number of collections. It is as distinct from *I. Setchellii* as almost any two species of the section *Phyleilema* are from each other. The much greater reduction of the cyme, the larger hypanthium and calyx, and the petiolate, obovate, obtuse leaves adequately distinguish *I. fragrans* from the species under consideration.

I am glad to dedicate this species to Dr. William Albert Setchell of the University of California, long one of the most prominent figures in plant taxonomy and distribution in the Pacific area, and whose kind personal interest in my botanical career since its beginning I sincerely appreciate.

Ixora St.-Johnii Fosberg, n. sp. (figs. 4, *f*; 6).

Arbor maxime 6 m., folia elliptica subcoriacea maxime 15 cm. longa 7.5 cm. lata, pedunculus robustus 2.5-5.5 cm. longus, bracteae foliam similes 8 cm. longae 4.5 cm. latae, petioli bractearum robusti 6-10 mm. longi, pars cymi supra bracteas reductus ad 3 ordinem florarum pedicellatarum, fructus lata ellipsoideus 12 mm. longus 10 mm. latus niger.

Tree up to 6 m. tall, branchlets terete, internodes variable; leaves subcoriaceous, glossy green above, pale beneath, elliptical, up to 15 cm. long, 7.5 cm. wide, apex acute to slightly acuminate, with the point blunt, base acute, petiole heavy, slightly winged, 5-15 mm. long; stipules 5-9 mm. long, ovate, connate to 1.5 mm., carinate, long acuminate, the prolonged apices free in the bud; cymes terminal on rather long lateral branches, peduncles heavy, 2.5-5.5 cm. long; bracts similar to the leaves, but only up to 8 cm. long, 4.5 cm. wide, petioles heavy, 6-10 mm. long; part of cyme above bracts reduced to 3 rows of pedicellate flowers on the enlarged node from which the bracts also arise; flowers not available; fruit (probably not quite mature) black, broadly ellipsoidal, 12 mm. long, 10 mm. broad, crowned with the scar and a few remnants of the apparently somewhat persistent calyx, 2 mm. in diameter, pedicellate, pedicels 3-4 mm. long, 1.5-2 mm. thick.

Society Islands: Huahine, Huahine Nui, north ridge of Mount Matoereere, alt. 600 m., Oct. 1, 1934, *St. John 17156* (type).

This is one of the most distinct species in the section *Phyleilema*, its bracts not resembling those of any other known species. Due to the lack of flowers it is, in fact, not altogether certain that it belongs

[2]**Ixora moorensis** (Nad.) Fosberg, n. comb.
Hitoa moorensis Nad.: Journ. de Bot., **13**:2, 1899.

in this genus, though the resemblance in the fruit and most of the vegetative characters make it most probable that it belongs here. It is not particularly closely related to any of the other species.

This species is named for my teacher, Dr. Harold St. John of Bishop Museum and the University of Hawaii, collector of the only known collection, and to whose energy and enthusiasm, the abundance of the botanical collections brought back by the Mangarevan Expedition is very largely due.

FIGURE 6.—*Ixora St.-Johnii.*

Ixora fragrans (Hook. and Arn.) Gray: Amer. Acad., Proc., **4**:39, 1860 (fig. 4, *a*).

Cephaelis fragrans Hook. and Arn.: Bot. Beechey's Voy., 64, pl. 13, 1832.

Shrub 2-4 m. tall; leaves variable, obovate to elliptical or oval, up to 13 cm. long, usually 6-8 cm., apex obtuse, base acute to cordate, petiole 4-8 mm. long; peduncles 1-2 cm. long, bracts ovate to cordate, obtuse, on petioles 1-2 mm. long, part of inflorescence above bracts reduced to 3 flowers on pedicels about 1 mm. long; free portion of calyx less than 1 mm. long, prominently 4(?) dentate; corolla tube 12-14 mm. long, lobes a little over half that length, lanceolate, 4(?) in number; fruit ellipsoidal to globose or ovoid, black.

Henderson Island: north end, alt. 15 m., June 17, 1934, *St. John and Fosberg 15053;* same locality and date, alt. 30 m., *St. John and Fosberg 15117;* same locality, alt. 33 m., June 18, 1934, *St. John and Fosberg 15140½, 15142, 15144*; north center, alt. 30 m., June 20, 1934, *St. John and Fosberg 15163.*

The above description is only intended to include the important diagnostic characters. Hooker and Arnott's description says that the calyx and corolla are 4-lobed, while their plate shows them to be 5-lobed. The available collections are all in fruit, and while the calyces are in some cases still persistent, it is very difficult to discern whether some are really 5-lobed or are merely damaged, due to enlargement of the fruit. This species is most closely related to *I. bracteata.*

Ixora brevipedunculata Fosberg, n. sp. (figs. 4, *d*; *7*).

Folia ovata vel elliptica, apex acuta vel subacuminata, basis rotundus raro acutus vel cordatus, lamina 10 cm. longa 4 cm. lata, petiolus 4 mm. longus, pedunculi 1-7 mm. longi, bracteae sessiles 0.5-2 cm. longi 0.5-1.5 cm. lati, pars cymi supra bracteas reducta, cymulae 1-5 3-floriferae, cymulae hypanthiaque breve hirsuti-pilosa, hypanthia 1.5-2.5 mm. longa, calyx 1.5 mm. longa 4-dentata, tubus corollae 14-18 mm. longus, lobi 9-10 mm. longi, antheres lineares 5 mm. longi, fructus glabratus ellipsoideus 12-13 mm. longus 9 mm. latus.

Shrub up to 6 m. tall, branchlets terete, internodes variable; leaves ovate to elliptical, apex acute to slightly acuminate, base rounded or rarely acute to cordate, blade up to 12 cm. long, usually 10 cm., up to 6 cm. wide, usually 4 cm., petiole 2-6 mm. long, usually 4 mm., slightly winged; stipules 6-10 mm. long, ovate, long acuminate or aristate, strongly carinate, connate up to 1.5 mm.; cymes commonly on lateral branchlets, peduncles 1-7 mm. long; bracts 0.5-2 cm. long, usually about 1 cm., 0.5-1.5 cm. wide, usually about 1 cm., thin, ovate to more commonly elliptical or obovate, apex acuminate, base subcordate, sessile; portion of inflorescence above bracts reduced to 1 to 5 3-flowered cymules, each so reduced as to be nothing but a ridge with 3 pedicellate flowers on it, the cymules next to the bracts often further reduced to 1 flower, the cymules and the hypanthium shortly hirsute-pilose; hypanthium 1.5-2.5 mm. long, calyx 1.5 mm. long, thin, shortly 4-dentate, almost glabrous outside, pilose inside;

corolla tube 1 mm thick, 14-18 mm long, rarely as short as 9 mm or as long as 20 mm, pinkish, lobes lanceolate-acuminate, 9-10 mm long, cream-white, fragrant, anthers linear, 5 mm long, exserted and hanging in the sinuses, pistil exserted 5-6 mm, stigma 2-3 mm long, bifid, fruit 12-13 mm long, 9 mm wide, red, glabrate, ellipsoidal, crowned almost until maturity with the persistent calyx

Austral Islands Tubuai, south slope of Panee, alt 350 m, Aug 23, 1934, *St John 16528* (type), north ridge of Panee, alt 300 m,

FIGURE 7—*Ixora brevipedunculata*

Aug. 23, 1934, *St. John 16526;* southwest ridge of Taitaa, alt. 320 m., Aug. 20, 1934, *St. John 16466.*

Quite distinct, resembling some of the Samoan species in the hirsute-pilose cyme and hypanthium, and the number of flowers, but differing from all species in the section in the very short peduncles.

Ixora raivavaensis Fosberg, n. sp. (fig. 4, *g*).

Folia 10-15 cm. longa elliptica, petioli robusti 10-15 mm. longi, bracteae ovatae maxime 5 cm. longae 4 cm. latae, pars cymi supra bracteas reducta ad 2-3 cymulae, fructus ellipsoideus 13-18 mm. longus 10 mm. latus.

Shrub up to 2.5 m. tall, branchlets terete, internodes long, mostly over 3 or 4 cm.; leaves large, elliptical, mostly 10-15 cm. long; apex more or less blunt-acuminate, base obtuse or more commonly acute, petiole heavy, on larger leaves 10-15 mm. long; stipules 6-10 mm. long, long-ovate, long-acuminate, strongly carinate, connate to 2 mm., peduncles 1-2.5 cm. long; bracts up to 5 cm. long, 4 cm. wide, ovate, apex acute or obtuse, base round or cordate, petiole 1.5-3 mm. long; part of inflorescence above bracts reduced to, usually, 2-3 tiny cymules side by side, these on peduncles from 5 mm. long to almost sessile, pedicels 1 mm. long, tiny sterile or cyme-bearing branchlets sometimes appearing in axils of the bracts; flowers not available; fruit 13-18 mm. long, 10 mm. thick, ellipsoidal, somewhat truncate distally, greenish streaked with magenta pink, the pink becoming more pronounced with age, calyx scar 2.5-3.5 mm. across.

Austral Islands. Raivavae: south slope of Mount Muanui, alt. 200 m., Aug. 8, 1934, *Fosberg 11700*; east slope of Mount Muanui, alt. 190 m., Aug. 8, 1934, *St. John 16042* (type); slope northeast of Vaiuru, alt. 40 m., Aug. 10, 1934, *Fosberg 11726.*

This species is probably closest to *I. Stokesii,* differing chiefly in that the inflorescence is not nearly so much reduced. It is also rather close to *I. marquesensis* of the Marquesas.

Ixora bracteata Cheeseman: Linn. Soc. Lond., Trans., II, **6**:283, 1903.

Austral Islands. Raivavae: slope up to pass south of Raiurua, alt. 80 m., Aug. 3, 1934, *St. John and Fosberg 15803*; south slope of Matotea, alt. 275 ft., April 19, 1922, *A. M. Stokes 76.*

With no flowers available it is with some doubt that I refer the Raivavae material cited above to *I. bracteata* of Rarotonga. Brown called the Stokes specimen *I. fragrans* with the comment that it had somewhat more prominent veins than that from Henderson Island. The only very marked difference between *I. fragrans* and *I. bracteata* is in the much longer corolla of the latter. I have seen no corollas of Raivavae material, so the determination is very uncertain. The pronounced rusty appearance of the leaves and the shorter peduncle

common to Raivavae and Rarotonga plants, and the fact that relationship with Rarotonga seems more logical than with Henderson Island lead me to associate the Raivavae plants with *I. bracteata* for the present. Little is known of the flowers of *I. fragrans*. Perhaps when further collections of flowering material from all three islands are made, the two species may be found to be identical.

Ixora Stokesii F. Brown: B. P. Bishop Mus., Bull. **130**:304, 1935 (fig. 4, *b*).

Rapa: Area, alt. 150 m., July 2, 1934, *St. John and Fosberg 15334*; Kopenena, alt. 125 m., July 12, 1934, *St. John and Maireau 15509*; east side of peak between Ahurei Bay and Atanui Valley, alt. 120 m., July 3, 1934, *Fosberg 11369*; north slope of Mount Lekie, alt. 250 m., July 20, 1934, *St. John and Maireau 15629*; Oromanga forest, south side of Mount Tangikou, alt. 150 m., July 11, 1934, *St. John and Maireau 15480*; same locality and date, alt. 200 m., *St. John and Maireau 15476*.

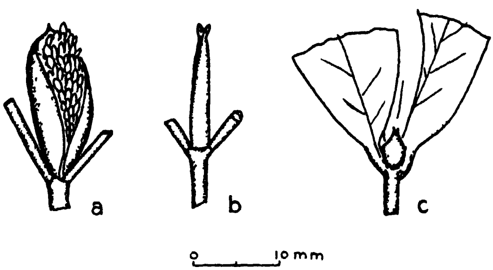

FIGURE 8.—Species of *Psychotria*, nodes with stipules: *a, P. raivavaensis*, showing calyptra opening and inflorescence emerging; *b, P. Grantii; c, P. temehaniensis.*

This species differs from *I. fragrans* to which it is most closely related in that the leaves are more commonly elliptical, apex acute, petiole somewhat longer, stipules much longer, bracts sessile or on petioles less than 1 mm. long, flowers completely sessile, calyx twice as long, less prominently dentate, corolla tube considerably longer, lobes longer and the fruit dark red. The cyme is more completely reduced in this than in any other species of *Ixora*.

Ixora macrothyrsa Teijm. and Binn.: Gard. Chron., **2**:267, 1884.

Mangareva (Gambier) Islands: Mangareva, Point Teone Kura,

alt. 2 m., June 5, 1934, *Fosberg 11125*; Rikitea, alt. 2 m., June 1, 1934, *Fosberg 11088*.

Austral Islands: Rurutu, Moerai, alt. 2 m., Aug. 29, 1934, *Fosberg 11990*.

This common cultivated species is grown as an ornamental in various parts of Polynesia. Its original home is in the East Indies.

Ixora odorata Hook.: Bot. Mag., 71, pl. 4191, 1845.

Mangareva (Gambier) Islands: Mangareva, Rikitea, alt. 2 m., May 27, 1934, *St. John 14579*.

This cultivated species was also observed in Tahiti. Its original home is in Madagascar.

PSYCHOTRIA

The *Psychotria* of southeastern Polynesia present a large number of distinct, yet in many cases closely related species. Collections are few in number and for some species, sterile or minus either fruit or flowers. A comprehensive revision would be desirable, including an investigation of the relationships of the southeastern Polynesian species to those of the other parts of Polynesia and the western Pacific.

All of the species of southeastern Polynesia seem to be rather closely related, except possibly two in the Society Islands and one or two in the Marquesas. The group to which the great majority belong is characterized by calyptrate stipules, usually with four free lobes at the apex, enclosing the inflorescences, and the terminal bud borne at the node where they are situated. As soon as the above-mentioned organs start to enlarge the stipules are shed. The pyrenes in the fruit are usually tricarinate.

No attempt will be made here to treat species not collected by the Mangarevan Expedition.

Psychotria speciosa Forst.: no. 89 in Fl. Ins. Austr. Prodr., 16, 1786.

Cephaelis speciosa (Forst.) Spreng.: Syst. Veg., ed. 16, 1:749, 1825.

Uragoga speciosa (Forst.) Drake: Ill. Fl. Ins. Mar. Pac.: 38, pl. 15, 1886.

Society Islands: Tahiti, east side of south ridge of Orofena, alt. 1,220 m., Sept. 20, 1934, *St. John and Fosberg 17039*.

Psychotria tahitensis (Drake) Drake: Ill. Fl. Ins. Mar. Pac., 199, 1890.

Uragoga tahitensis Drake: Ill. Fl. Ins. Mar. Pac.: 42, pl. 17, 1886.

Society Islands: Tahiti, east side of south ridge of Orofena, alt. 1,250 m., Sept. 26, 1934, *St. John and Fosberg 17097*.

This species, rather common in the high rain forests of Tahiti, was the one considered to be *P. asiatica* by Nadeaud.

FIGURE 9.—*Psychotria Grantii.*

Psychotria Grantii Fosberg, n. sp. (figs. 8, *b*; 9).

Frutex, folia obovata coriacea, stipulae calyptratae 2 cm. longae, cymi pauciflori terminales robusti trichotomi, calyx integer 2 mm. longus infundibuliformis, corolla pentamera, pyrenae fructi tricarinatae.

Shrub up to 4 m. tall, with heavy cylindrical branchlets, internodes 1-3 cm. long; leaves obovate, rarely elliptical, apex acute or somewhat acuminate, rarely obtuse, base cuneate-attenuate, blade up to 12 cm. long, 5.5 cm. wide, coriaceous, glabrous above, somewhat brown-woolly along the midrib beneath, petiole winged, 1-1.5 cm. long; stipules forming a calyptra up to 2 cm. long, slightly bifid at apex; cymes few flowered, terminal in threes, becoming lateral by a branch arising at the base of the cymes, cymes elongating to 6 cm. in fruit, cyme heavy, once trichotomous, then each branch bearing 3 pedicellate flowers at apex, pedicels 1-3 mm. long, elongating in fruit to 4-5 mm.; ovary and calyx golden appressed hirtellous, becoming glabrate in fruit, ovary 1 mm. long, calyx entire, 2 mm. long, funnelform; corolla pentamerous, glabrous externally, purplish white in bud, not known open, tube at least 5 mm. long, lobes at least 5 mm. long; fruit ellipsoidal, 9-10 mm. long, 7 mm. wide, crowned by the persistent truncate calyx, pyrenes tricarinate.

Society Islands: Tahiti, east side of south ridge of Orofena, alt. 1,200 m., Sept. 26, 1934, *St. John and Fosberg 17100* (type); same locality, alt. 1,500 m., Sept. 25, 1934, *St. John and Fosberg 17121*; south of Orohena (Orofena), alt. 1,550 m., May 16, 1927, *L. H. MacDaniels 1487*.

This species was annotated in the herbarium by Grant as a new variety of *P. temehaniensis*, to which it bears a strong superficial resemblance. The form of the stipules, however, places it in the group centering around *P. tahitensis*. The coriaceous leaves, stiff, few flowered cyme, and the enlarged calyx persisting on the fruit amply separate it from the latter. The pyrenes of the fruit are tricarinate, while those of *P. temehaniensis* are, according to Moore, unicarinate.

Named for Dr. Martin L. Grant, Bishop Museum Fellow 1930-32, whose flora of the Society Islands, now in preparation, will doubtless clear up many of the difficult problems presented by the southeastern Polynesian flora.

Psychotria tubuaiensis Fosberg, n. sp. (fig. 10).

Folia elliptica vel obovata, cymi ternati, pedunculi trichotomi elongati, dentes calicis obtusae, tubus corollae 4-5 mm. longus, lobi 3 mm. longi anguste ovati, stylus 6-7 mm. longus.

Shrub up to 6 m. tall, branchlets almost terete, fistulose, internodes up to 2.5 cm. long, leaves up to 14 cm. long, 6 cm. wide, elliptical or obovate, obtuse to acute, slightly blunt-acuminate at apex, cuneate-attenuate at base, petiole 1.5-2 cm. long, blade with only a slight coppery tinge above when dry, with a conspicuous band of rusty-brown woolly-pilose hair 2 mm. wide extending along

each side of the midrib beneath; stipules 1.5 cm. long, forming a terminal calyptra, but apparently with no free lobes at apex, shed with the opening of the bud; cymes borne usually 3 at a node, the bud which prolongs the branch appearing a little to one side; peduncle elongate, up to 6 cm., once trichotomous, each branch bearing 3 shortly pedicellate flowers; calyx cup-shaped, 1-1.5 mm. long, teeth obtuse; corolla with tube and throat almost indistinguishable, salver-form, tube and throat together 4-5 mm. long, lobes 3 mm. long, narrowly ovate, glabrous except the throat, which is bearded; style 6-7 mm. long; fruit ellipsoidal, pyrenes 10 mm. long, about 5 mm. wide.

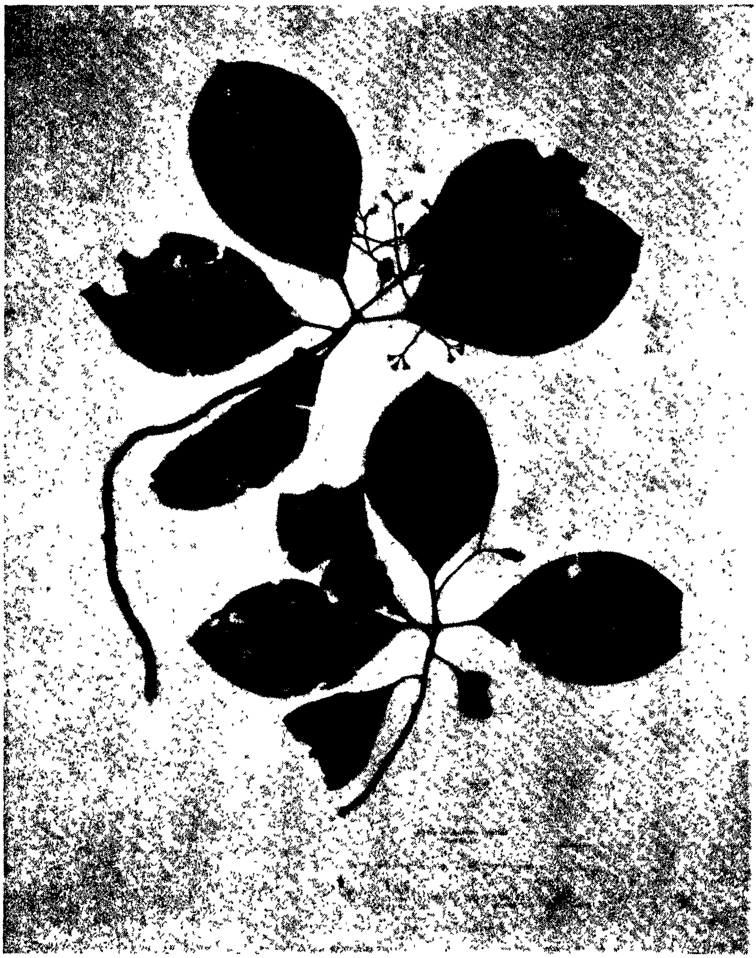

FIGURE 10.—*Psychotria tubuaiensis.*

Austral Islands: Tubuai, west side of Taitaa, alt. 370 m., Aug. 23, 1934, *St. John 16543*; northeast slope of Taitaa, alt. 350 m., Aug. 20, 1934, *St. John 16447* (type).

Related to *P. raivavensis* and to *P. rapensis,* differing from the former in the once trichotomous cyme, shorter flowers and the larger pyrenes, and from the latter in the ternately borne cymes, the longer flowers and slightly narrower pyrenes.

Psychotria raivavaensis Fosberg, n. sp. (figs. 8, *a*; 11).

Cymi ternati, pedunculi trichotomi, ramuli cymorum trichotomi, calyx 2 mm. longa 4 mm. lata, tubus corollae 6-7 mm. longus, lobi 3 mm. longi, pyrenae ovalis 7 mm. longae 6 mm. latae.

Like *P. tubuaiensis* but with broader leaves, up to 7 cm. wide, 14 cm. long, on petioles 3-4 cm. long, apex of leaf obtuse to rounded, leaves on some plants completely glabrous beneath, others with a band of hair; the 3 cymes at one node sometimes on a short common peduncle, more often not, each cyme twice trichotomous, then each ultimate branch bearing 3 flowers on pedicels 0.5-1 cm. long; calyx 2 mm. long, 4 mm. broad; corolla tube plus throat 6-7 mm. long, lobes 3 mm. long, more narrowly ovate, throat somewhat less bearded; fruit with pyrenes 7 mm. long, 6 mm. broad, very broadly oval.

Austral Islands: Raivavae, south slope of Mount Muanui, alt. 200 m., Aug. 8, 1934, *Fosberg 11701* (type); same locality and alt., Aug. 6, 1934, *St. John and Zimmerman 15991*; south slope of Mount Taraia, alt. 230 m., Aug. 6, 1934, *St. John 16005, 16006, 16008.*

The last two collections cited have the leaves entirely glabrous beneath, but this character is variable, and the form does not seem worth naming.

This species is most closely related to *P. tubuaiensis.*

Psychotria rapensis F. Brown: B. P. Bishop Mus., Bull. **130**:309, 1935.

Rapa: Maungaeae, east of Mangaoa Peak, alt. 250 m., July 4, 1934, *St. John and Maireau 15376*; south slope of Mount Tepiahu, alt. 200 m., July 20, 1934, *St. John and Zimmerman 15611*; southeast slope of Morongota, alt. 150 m., July 16, 1934, *St. John and Maireau 15606*; Taratika, east side of Mount Perahu, alt. 450 m., July 15, 1934, *St. John and Maireau 15563.*

Psychotria temehaniensis Moore: B. P. Bishop Mus., Bull. **102**:46, 1933 (fig. 8, c).

Society Islands: Raiatea, Temihani Plateau, alt. 600 m., Oct. 5, 1934, *St. John 17278.*

This species is apparently not closely related to *P. tahitensis* and its allies, as its stipules are only 4.5 mm. long, ovate, bluntly cuspidate, and show no signs of forming a calyptrate bud sheath.

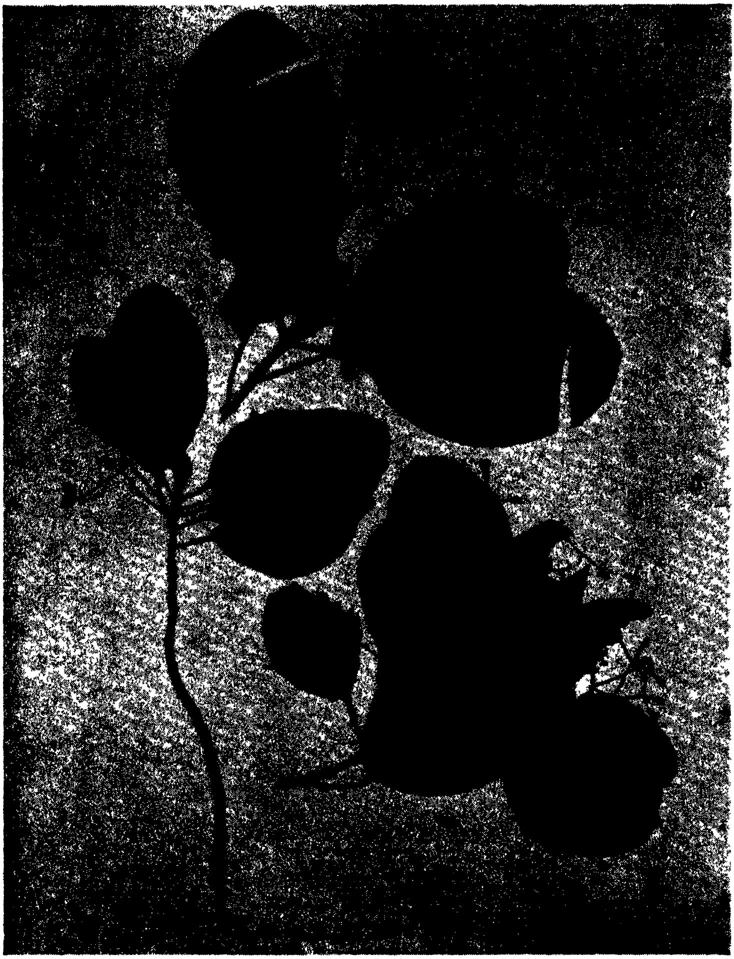

FIGURE 11.—*Psychotria raivavaensis.*

Psychotria sp.

Shrub 5 m. tall, branchlets cylindrical, internodes 1-2.5 cm. long, leaves obovate-cuneate, rather abruptly contracted to a winged petiole at base, apex acuminate, up to 15 cm. long, 5.5 cm. wide, thin-coriaceous, glabrous above, also beneath except for a close line of brown wool along each side of the midrib,

veins almost at right angles to midrib, somewhat purplish when dry, petiole 1 cm. long; stipules broadly ovate, obtuse, slightly mucronate, 7 mm. long, connate, forming a sheath, persistent to the second or third node, brown pilose inside; fruit described as red, but not present on the specimen, apparently lost in drying.

Society Islands: Huahine, Huahine Nui, Matoereere, alt. 400 m., Oct. 1, 1934, *St. John 17175.*

I hesitate to name this plant from sterile material. Its stipules seem to relate it to *P. temehaniensis,* though its general appearance is quite different.

GEOPHILA

Geophila herbacea (Jacq.) O. Kuntze: Rev. Gen. Pl., **1**:300, 1891.

Psychotria herbacea Jacq.: Enum. Pl. Carib., 16, 1760.

Geophila reniformis D. Don: Fl. Nepal. Prodr., 136, 1825.

Uragoga herbacea (Jacq.) O. Kuntze: Rev. Gen. Pl., **1**:300, 1891.

Society Islands: Tahiti, District de Pare, Fautaua Valley, alt. 60 m., May 7, 1934, *St. John and Fosberg 14123.*

Identical with collections examined from the western Pacific and Malaysia.

NERTERA

Nertera granadensis (Mutis) Druce: Bot. Exch. Club of British Isles, Rept. of 1916, 637, 1917.

Gomozia granadensis Mutis: in Linn. f., Suppl. Pl., 129, 1781.

Nertera depressa Banks and Sol.: in Gaertn., de Fruct. et Sem. Pl., **1**:124, 1788.

Society Islands: Tahiti, south ridge of Orofena, alt. 1,550 m., Sept. 22, 1934, *St. John and Fosberg 16985.*

Careful comparison has failed to reveal any significant difference from the wide spread plant which has been called *N. depressa,* though Nadeaud has recorded *N. setulosa* from Tahiti (no. 350 in Enum. Pl. Ile Tahiti, 52, 1873). I have not seen specimens identified by Nadeaud, but it is doubtful if *N. setulosa* occurs outside New Zealand. The specimen cited above is much like certain narrow leafed Hawaiian ones.

The plant is decidedly rare in Tahiti, at least in the part explored by the Mangarevan Expedition. Only one isolated patch was seen, growing on the face of a bare, wet, almost perpendicular cliff just below the crest of the main south ridge of Orofena.

It is with some hesitation that I take up the name of *N. granadensis* in place of the long established *N. depressa* without having had access to the type specimen, but so far no one has presented any evidence favoring the subdivision of the widespread *N. depressa* excepting its wide distribution, and *N. granadensis* is certainly the oldest name for the group taken in a broad sense.

COPROSMA

In his treatment of the southeastern Polynesian group of species of *Coprosma* in his recent monograph of the genus (B. P. Bishop Mus., Bull. **132**, 1935), Oliver obviously had too little material at his disposal for an adequate picture. The mass of collections on which the present notes are based is by far the greatest and most representative that has been brought together, though some items are still to be desired, such as fruit of *C. Cookei* and *C. velutina* var. *Andersonii,* flowers of *C. taitensis* var. *Oliverii,* and fertile material of *C. rapensis* var. *mangarevica.* Intelligent future collecting should easily correct these deficiencies except possibly the last mentioned.

The present study maintains the integrity of the group of species centering around *C. taitensis,* though necessitating drastic realignment of the species within the group. Also it effectually disposes of the false group of *C. oceanica* created by Oliver, and introduces in *C. Cookei* another very definite element of relationship between the flora of Rapa and that of the New Zealand region. The species, as here treated, are clear and easily distinguished from each other.

Coprosma taitensis Gray: Am. Acad., Proc., **4**:49, 1860 (figs. 12, *a;* 13).

Coprosma tahitensis Nad.: no. 340 in Enum. Pl. Ile Tahiti, 50, 1873.

Coprosma Nadeaudiana Drake: Ill. Fl. Ins. Mar. Pac., 201, 1890.

Specimens of this species differ somewhat in degree of hairiness, thickness of branchlets, length of internodes, and in size and shape of leaves. However, these differences seem to be correlated somewhat with the degree of exposure of the habitat, and no sharp lines can be drawn between them. Drake's statement in describing *C. Nadeaudiana,* that the description of *C. taitensis* Gray more nearly fits a Tuamotuan species has been apparently the foundation for considerable confusion since, including the describing of *C. oceanica* Oliver,

based on *Hedyotis romanzoffiensis* (*Kadua romanzoffiensis, Gouldia romanzoffiensis*). Certainly the latter was the plant that Drake had in mind, as there are no *Coprosma* known from the Tuamotus, and the specimen he cites (Savatier, Morurua), of which I have seen a photo, belongs there. *C. Nadeaudiana* is considered both by Oliver and by Grant to be identical with *C. taitensis,* and a photograph of the type bears this out.

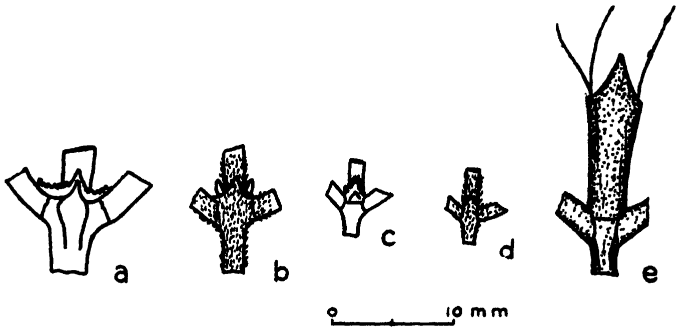

FIGURE 12.—Species of *Coprosma,* nodes with stipules: *a, C. taitensis; b, C. velutina; c, C. rapensis* var. *typica, d, C. rapensis* var. *mangarevica; e, C. Cookei.*

One specimen from Orofena certainly seems to merit varietal recognition because of its glabrous branchlets, lack of domatia, and differently shaped fruits.

Although a careful search was made for it, no *Coprosma* was found on Tubuai. A later examination of the specimen (*Aitken 910*) reported by Brown (B. P. Bishop Mus., Bull. **130**:317, 1935) as *C. tahitensis* Gray showed that the plant was *Psidium Cattleyanum.*

Coprosma taitensis Gray var. **genuina** Fosberg, n. nom. (fig. 13, *a*).
The typical form of the species.

Society Islands: Tahiti, Orofena, east side of south ridge, alt. 1,300 m., Sept. 26, 1934, *St. John and Fosberg 17098*; south ridge of Orofena, Sept. 22, 1934, *St. John and Fosberg 16996*; same locality, alt. 1,600 m., Sept. 24, 1934, *St. John and Fosberg 17074;* same locality, alt. 1,950 m., *St. John and Fosberg 17065.*

Numerous other collections are represented in the Bishop Museum herbarium.

Coprosma taitensis Gray var. **Oliverii** Fosberg, n. var. (fig. 13, *b*).

Ramuli glabri, domatia nulla, fructi ellipsoidei.

Differing from var. *genuina* in the completely glabrous branchlets, lack of domatia in the leaves, and in ellipsoid rather than broadly obovoid fruits.

Society Islands: Tahiti, south ridge of Orofena, alt. 1,600 m., Sept. 22, 1934, *St. John and Fosberg 17006* (type).

Named for Mr. W. R. B. Oliver, of Wellington, New Zealand, monographer of the genus *Coprosma.*

This variety would have to belong to *C. glabrata* Moore if that species were upheld, but as var. *Oliverii* is intermediate between it and *C. taitensis* and the differences between the latter and Moore's two species are slight, the following reductions seem to be necessary.

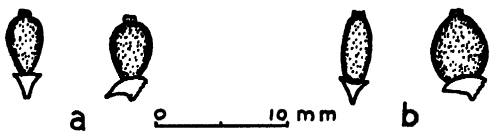

FIGURE 13.—Fruits of varieties of *Coprosma taitensis: a,* var. *genuina; b,* var. *Oliverii.*

Coprosma taitensis Gray var. **glabrata** (Moore) Fosberg, n. comb.
Coprosma glabrata Moore: B. P. Bishop Mus., Bull. **102**:41, 1933.

Coprosma taitensis Gray var. **raiateensis** (Moore) Fosberg, n. comb.
Coprosma raiateensis Moore: B. P. Bishop Mus., Bull. **102**:41, 1933.

These two species were only weakly separated from *C. taitensis* and from each other by differences in pubescence, denticulation of stipules, shape of leaves, and size and shape of fruit. The discovery of *C. taitensis* var. *Oliverii,* which is obviously a variant of *C. taitensis,* but which on technical characters would have to go into *C. glabrata* makes it useless to try to maintain them as separate species. I have examined type material of both.

Coprosma setosa Moore: B. P. Bishop Mus., Bull. **102**:42, 1933.

Society Islands: Raiatea, Temihani Plateau, alt. 750 m., Oct. 5, 1934, *St. John 17280.*

This species seems distinct enough.

Coprosma velutina Fosberg, n. sp. (figs. 12, *b*; 14).

Stipulae latae triangulares valde denticulato-glandulosae valde mucronatae leviter connatae et adnatae ad bases petiolarum, dioica, calyx absens, stamina penta, lobae florae pistillatae tubam longiores, fructus 7 mm. longus 2-3 mm. latus oblongus vel ovoideo-oblongus.

Shrub or small tree up to 5 m. tall; branchlets somewhat fleshy, 4-sided; internodes short, 0.5-2.5 cm. long, nodes prominent; leaves chartaceous, elliptical to ovate, apex obtuse to rounded, base acute to slightly attenuate to a petiole 8-17 mm. long, slightly winged, blade up to 8.5 cm. long, 4.5 cm. wide, usually smaller, upper side of midrib and lower side of blade sparsely puberulent, margin ciliolate, domatia large, triangular, very hairy; stipules broadly triangular, strongly denticulate-glandular, stoutly mucronate, slightly connate, adnate to the bases of the petioles; apparently dioecious; (inflorescences and flowers described under var. *typica*); fruit 7 mm. long, 2-3 mm. thick, orange, glabrous, oblong or ovoid-oblong, crowned by persistent calyx.

Related most closely to *C. taitensis* Gray, but differing in being densely pubescent on many parts, in the shape of the stipules, in the lack of a calyx and in having 5 stamens in staminate flowers, in having the lobes longer than the tube in the smaller pistillate flowers, and most noticeably in the oblong or oblong ovoid, larger fruit.

Two varieties exist, one on Raivavae and one on Rurutu, of the Austral Islands. It is rather surprising not to find a variety on Tubuai, situated between these two. However, the original vegetation of Tubuai is almost completely destroyed. Possibly if a *Coprosma* ever existed there it may not have survived the devastation produced by fires set by natives and the weeds and goats introduced by misguided Europeans.

Coprosma velutina Fosberg var. **typica** Fosberg, n. var.

Ramuli valde velutino-pubescentes, petiolus velutinus, costa et nervi foliae velutinae, stipulae dense pubescentes, pedunculi puberuli, bractae setosae.

Branchlets strongly velutinous-pubescent; petiole and under side of midribs and veins velutinous; stipules densely pubescent; peduncles up to 0.5 mm. long, puberulent, topped by a shallow cup formed by a pair of oblong-lanceolate bracts and their triangular stipules, these setose; in staminate plants this cup contains a small, subcapitate cluster of sessile flowers, these without calyx, the corollas somewhat glabrous outside, apparently (as nearly as can be determined from not fully developed buds) with a rather short tube and 5 blunt oblong lobes and 5 stamens with linear-oblong anthers; on pistillate plants the cup may bear 3 sessile or subsessile flowers, or 1 or more secondary peduncles, each bearing a cup with 3 flowers, the ovaries glabrous, less than 1 mm. long, calyx half to almost the length of the ovary, slightly spreading, pubescent, lobes unequal, one side usually longer than the other, irregular, making the calyx appear erose, ciliate, corolla 1.5-2 mm. long, tube shorter than the lanceolate blunt lobes, glabrous, stigmas glandular-puberulent, linear, 5-8 mm. long, coiling when dry.

Austral Islands: Raivavae, east slope of Mount Muanui, alt. 250 m., Aug. 8, 1934, *St. John 16035* (type); south side of Mount Taraia, alt. 250 m., Aug. 6, 1934, *St. John and Kondo 15995;* south side of saddle between Mount Turivao and Mount Muatapu, alt. 170 m., Aug. 11, 1934, *Fosberg 11780.*

Coprosma velutina Fosberg var. **Andersonii** Fosberg, n. var.

Ramuli petioli et nervi puberulentes, stipuli et cymi bracteaèque glabrati.

FIGURE 14.—*Coprosma velutina.*

Differing from var. *typica* in having puberulent branchlets, petioles and under sides of leaf veins; stipules glabrate; cymes, bracts, and inflorescence stipules glabrate; flowers unknown.

Austral Islands: Rurutu, 1.5 km. north of Avera, alt. 350 m., Aug. 25, 1934, *St. John and D. Anderson 16625* (type).

Named for Donald Anderson, Bishop Museum, one of the collectors of the type.

Coprosma rapensis F. Brown: B. P. Bishop Mus., Bull. **130**:316, 1935.

This species is, as Brown says, closest to *C. laevigata* Cheeseman of Rarotonga, and his statement of differences is, as far as it goes, correct, but the most important difference is not noted, the noticeably articulate stipules of *C. rapensis*.

Since much more material is now available and since Brown's description and figures are in certain particulars inaccurate, I am including a rather full description under var. *typica,* based on all the Rapa material available, including that used by Brown. Only material collected by the Mangarevan Expedition is cited.

Three varieties are known, from Rapa, Mangareva, and Pitcairn, which distribution is of considerable interest in the study of the geological and botanical history of southeastern Polynesia.

Coprosma rapensis F. Brown var. **typica** Fosberg, n. nom. (fig. 12, *c*).

Shrub or small tree up to 7 m. high, usually 2-3 m.; branchlets slender, somewhat 4-sided, papillose-puberulent, internodes 0.5-1.5 cm., rarely 2.5 cm. long; leaves glabrous, elliptic or elliptic-lanceolate to obovate or oblanceolate, apex acute to somewhat acuminate, base acute to somewhat attenuate, petiole 4-8 mm. long, slightly winged, blade chartaceous to subcoriaceous, up to 6 cm. long and 2 cm. broad, usually about 3 cm. long and 1 cm. broad, very variable in shape and texture, domatia variable, in some specimens large, in others small, in others absent, veins forming a fine network; stipules triangular-acuminate, glabrous, up to 2 mm. long, conspicuously articulate to the node, persistent on several nodes back of the apex of the stem; peduncles papillose puberulent, up to 6 mm. long, bearing at the top a pair of small lanceolate bracts 1-2 mm. long, and their stipules, and either several sessile flowers or one or more branches similar to the peduncle but shorter, bearing several sessile flowers; dioecious; staminate flowers with no calyx, corolla somewhat funnel-shaped, tube about 1 mm. long, lobes ovate-acute, 1 mm. long, filaments papillose-puberulent, 3-4 mm. long, anthers oblong, apiculate, 2 mm. long; pistillate flowers with ovary less than 1 mm. long, calyx about 0.5 mm. long, with sharp triangular-lanceolate teeth, corolla with tube 1 mm. long, lobes lanceolate, 1.5 mm. long, stigmas up to 8 mm. long; fruit orange-red, spherical to slightly flattened perpendicularly to the septum, so that the cross section may be circular or elliptical, 4-5 mm. in diameter.

Rapa: Peatuakaviri, west of Mount Tautautu, alt. 210 m., July 6, 1934, *St. John and Maireau 15407;* Mount Ruatara, alt. 100 m., July 9, 1934, *Fosberg 11465;* Oroi, Angairao Bay, alt. 150 m., July 9, 1934, *St. John and Maireau 15453;* Taratika, east side of Mount Perahu, alt. 400 m., July 15, 1934, *St. John and Maireau 15569;* Anarua Valley, southeast ridge of Mount Perahu, alt. 300 m., July 12, 1934, *Fosberg 11522, 11523;* west ridge of Morongota, alt. 240 m., July 20, 1934, *Fosberg 11600;* east slope of Mount Ruatara, alt. 70 m., July 9, 1934, *Fosberg 11472;* Maitua, cliffs of Mount Tautautu, alt. 210 m., July 11, 1934, *Fosberg 11490.*

Brown's figure (B. P. Bishop Mus., Bull. **130**:317, fig. 55, 1935) does not correctly represent the calyx of the pistillate flowers, not showing the prominent teeth; also the anthers in the staminate flowers are rather too small and the filaments too short.

Brown and Oliver both consider the leaves membranous, which is not correct, though in a few specimens, they might be considered thin-chartaceous. Oliver speaks of *C. laevigata* as agreeing with *C. rapensis* in the absence of domatia, though in his description he says that *C. rapensis* has domatia. Both statements are correct as the domatia vary from conspicuous to none at all.

Coprosma rapensis F. Brown var. **benefica** (Oliver) Fosberg, n. comb.

Coprosma benefica W. R. B. Oliver: B. P. Bishop Mus., Bull. **132**:137, 1935.

Very close to *C. rapensis* var. *typica,* differing in having the branchlets, stipules, under sides of the midribs of the leaves, and the inflorescence hirtellous, in the thinner, sometimes larger leaves with minutely ciliolate margins, in the larger, blunter bracts, and in the more hairy stigmas, all of which characters vary considerably. In fact, one collection (*Fosberg 11267½*) can scarcely be told from var. *typica,* differing only in that the inflorescence is a trifle more hairy.

Pitcairn Island: hills above Adamstown, June 14, 1934, *Fosberg and Christian 11267½;* Middle Hill, alt. 220 m., June 14, 1934, *Fosberg and Clark 11313; 11317;* Parlver Valley ridge, alt. 250 m., June 13, 1934, *St. John 14984;* Outer Valley, alt. 200 m., June 14, 1934, *Fosberg and Clark 11301;* The Rope, alt. 200 m., June 14, 1934, *St. John 15004.*

Coprosma rapensis F. Brown var. **mangarevica** Fosberg, n. var. (fig. 12, *d*).

Ramuli elongati graciles teretes, folia membranacea ciliolata, petioli sparse pilosuli, costae infra sparse pilosulae, stipuli breves.

Differing from var. *typica* in the much more elongate, slender, nearly terete branchlets, longer internodes, leaves truly membranous, much more broadly elliptical, with ciliolate margins and sparsely pilosulous petiole and under side of midrib, and in the very short stipules which are not so markedly articulate.

Mangareva (Gambier) Islands: Mangareva, south side of Mount Mokoto, alt. 320 m., June 4, 1934, *St. John 14875* (type); same locality, alt. 350 m., June 3, 1934, *St. John and D. Anderson 14865;* same locality, alt. 340 m., June 2, 1934, *St. John and D. Anderson 14842.*

Unfortunately the material of this variety is all sterile. With fertile material it may well prove to be a distinct species, though the characters evident in the sterile specimens do not justify separation. The hairiness is somewhat variable.

This variety is almost extinct, persisting only in one tiny patch of woods on a steep cliff.

Coprosma Cookei Fosberg, n. sp. (figs. 12, *e*; 15).

Ramuli glabri, internodi brevi, folia subcoriacea ovato-lanceolata, apex longe acuminata, basis acuto-attenuata, stipuli connati vaginati, imperfecte dioica, cymi subcapitati laterales, florae staminatae sine calycibus, stamini 8-12, antheres ovato-cordati vel ovato-oblongi, calyces florae pistillatae breves, lobae 4-5 linearae inaequalae, stigmatae 2 carnosae pubescentes.

Shrub or small tree up to 4 m. tall; branchlets glabrous, rather slender, square to subterete, internodes short, usually about 1 cm. long, nodes prominent on young branchlets; leaves glabrous, subcoriaceous, ovate-lanceolate, apex long-acuminate, base acute-attenuate into a petiole up to 1.5 cm. long, usually 1 cm. or less, winged above, blade up to 2 cm. wide and 6 cm. long, usually about 1 cm. wide and 4 cm. long, midrib and secondary veins prominent, secondaries subopposite to alternate, network fine and distinct, domatia prominent; stipules connate into a tubular sheath 8-15 mm. long, splitting and caducous as leaves and inflorescences enlarge, free portion acuminate, long-mucronate, 3-8 mm. long; incompletely dioecious; inflorescences, both staminate and pistillate, subcapitulate on slightly flattened axillary peduncles up to 1 cm. long, two at a node, with sometimes a reduced pistillate one extra in staminate plants, each peduncle surmounted by a pair of small oblanceolate bracts, and a stipular sheath so expanded as to form a bowl-shaped involucre, this bearing either 1-3 (or more) shortly pedunculate, 3-flowered cymules of pistillate flowers, or several sessile to shortly pedicellate staminate flowers, each subtended by a reduced pair of bracts and their stipules giving the appearance of a calyx, and suggesting that each flower represents a separate cymule, corresponding to those of the pistillate flowers; staminate flowers without calyx, corolla cup-shaped, tube about 2 mm. long, lobes oblong-lanceolate, blunt-acute, 2 mm. long, 1 mm. or less wide, 6-8 in number, stamens 8-12 or more attached in a mass at base of corolla tube, some poorly developed, others obviously the result of fusion of two, normal filaments up to 8 mm. long, anthers ovate-cordate to

ovate-oblong with cordate base, mucronate at apex, about 2 mm long, 1 mm wide, pendent, peduncles of pistillate cymules 2-5 mm long, central one usually about twice the length of the lateral ones, the three flowers at the top of each subtended by a much reduced ring or involucel of two bractlets and stipules, similar to that subtending each individual staminate flower, flowers sessile or very shortly pedicellate, ovary 1 5 mm long, 0 7 mm thick, calyx tube very short, only a ring bearing 4-6 linear strongly unequal lobes 0 5-1 5 mm long, 0 15-0 2 mm wide, blunt, corolla funnel-shaped, 3 5-4 mm long, lobes 4 equaling tube, spreading but not reflexed, linear-oblong, blunt, pistil of two elongate

FIGURE 15—*Coprosma Cookei*

cylindrical, fleshy, pubescent stigmas, up to 1 cm. long and 0.4 cm. thick, united only at the very base, whitish-translucent; fruit not available.

Rapa: Taratika, east side of Mount Perahu, alt. 350 m., July 21, 1934, *St. John, Fosberg, and Maireau 15674;* Maitua cliffs, base of Mount Tautautu, alt. 220 m., July 11, 1934, *Fosberg 11494, 11495;* cliffs and slopes above Area, alt. 100 m., July 3, 1934, *Fosberg 11373;* Mount Pukutaketake, alt. 340 m., July 24, 1934, *St. John 15712* (type); Area, alt. 90 m., July 3, 1934, *St. John and Maireau 15351;* Hiri Valley, south slope of Morongota, alt. 200 m., July 20, 1934, *Fosberg 11597.*

This species is dedicated to Dr. C. Montague Cooke, Jr., of Bishop Museum, leader of the Mangarevan Expedition, to whose intelligent and friendly direction may be attributed in large measure the remarkable success of the expedition.

Coprosma Cookei seems related to *C. acutifolia* of the Kermadec Islands, though in many ways it suggests the *C. longifolia* group of the Hawaiian islands. This latter resemblance, however, may be a case of parallel development, rather than actual relationship. From *C. acutifolia* it differs only in details of the flower and inflorescence, the vegetative parts being similar except for the somewhat longer petioles and much longer stipular sheath. The staminate flowers differ in the lack of a calyx and in the peculiar multiplicity of flower parts. The pistillate inflorescence is identical, but the flowers differ in the much longer calyx lobes and more funnel-shaped corolla with the lobes not reflexed. *C. Cookei* is apparently not at all related to any other southeastern Polynesian species.

The incompletely dioecious condition and the multiplicity of staminate corolla lobes and of stamens, part of the latter being variously fused and poorly developed, suggest a very peculiar genetic situation in this species.

MORINDA

Morinda Forsteri Seem.: Fl. Vit., 129, 1866.

Morinda umbellata var. . . . . of Gray: Am. Acad., Proc., 4:41, 1860.

Usually a woody vine, but certain specimens are recorded as shrubs; leaves usually subcoriaceous, usually slightly revolute at margin, varying in shape, but usually oblong or oblong-lanceolate, apex round to strongly acuminate; heads axillary on slender peduncles and in a terminal umbel, the heads varying greatly in size and number of flowers; flowers varying in color, outside greenish or

whitish to pink or dull red, inside white or cream to greenish yellow, glabrous or only slightly bearded in throat; fruit reddish purple.

Pitcairn Island: St. Pauls Valley, alt. 220 m., June 14, 1934, *St. John 15013.*

Henderson Island: north end, alt. 33 m., June 17, 1934, *St. John and Fosberg 15074;* north center, alt. 30 m., June 20, 1934, *St. John and Fosberg 15161.*

Austral Islands. Raivavae: northwest side of Pic Rouge, alt. 130 m., Aug. 5, 1934, *St. John and Fosberg 15960.* Rurutu: Mato Naa, alt. 75 m., Aug. 24, 1934, *St. John and Fosberg 16557;* 1.5 km. north of Avera, alt. 320 m., Aug. 25, 1934, *St. John and D. Anderson 16626;* north side of Moerai, alt. 15 m., Aug. 25, 1934, *St. John 16633.*

Society Islands. Raiatea, Temihani Plateau, alt. 600 m., Oct. 5, 1934, *St. John 17251;* Tahaa, east ridge of Mount Purauti, alt. 450 m., Oct. 11, 1934, *St. John 17389;* Huahine, Huahine Nui, north ridge of Mount Matoereere, alt. 400 m., Oct. 1, 1934, *St. John 17173.*

Though this species is close to *M. umbellata* L., it seems to differ sufficiently in the glabrous or almost glabrous corolla throat and in the reddish purple fruit. Its range, both geographical and altitudinal is very wide. It extends from Fiji and Tonga to the Marquesas, Henderson, and Pitcairn, and from practically sea level on coral limestone in Henderson and the Austral Islands to the high open bogs on Temihani plateau, Raiatea, and probably much higher in Fiji and Tahiti.

Morinda citrifolia L.: Species Plantarum, 176, 1753.

Tuamotu Archipelago. Anaa: Tukuhora, alt. 1 m., May 13, 1934, *St. John 14299.* Tepoto: alt. 1 m., May 16, 1934, *St. John 14342.*

Mangareva (Gambier) Islands. Mangareva: Rikitea, alt. 50 m., May 23, 1934, *St. John 14466;* Aukena, Point Mata Kuiti, alt. 10 m., May 28, 1934, *St. John 14628;* north side of Akamaru, alt. 3 m., May 29, 1934, *St. John 14713;* northeast end of Taravai, alt. 6 m., June 1, 1934, *St. John 14820;* west side of Agakauitai, alt. 5 m., June 8, 1934, *St. John 14939.*

Timoe (Crescent) Island: North Islet, June 25, 1934, *St. John and Fosberg 15213.*

Pitcairn Island, hills above Adamstown, alt. 100 m., June 14, 1934, *Fosberg 11266.*

Austral Islands. Raivavae: Vaiuru, alt. 3 m., Aug. 10, 1934, *Fosberg 11741.* Tubuai: Tapapatauai Islet, alt. 1 m., Aug. 19, 1934, *St. John 16412;* Mataura, alt. 5 m., Aug. 15, 1934, *St. John and Fosberg*

16281. Rurutu: hills northwest of Moerai, alt. 15 m., Aug. 24, 1934, *St. John and Fosberg 16589.* Rimatara: Anapoto, alt. 3 m., Sept. 4, 1934, *St. John and Fosberg 16874.* Maria: southwest islet, alt. 3 m., Sept. 6, 1934, *Fosberg 12115;* northeast islet, alt. 2 m., Sept. 6, 1934, *St. John 16962.*

Society Islands. Meetia: Fatia-po to Fareura, alt. 100 m., May 12, 1934, *St. John 14235.* Raiatea: Tetaro Islet, alt. 1 m., Oct. 4, 1934, *St. John and S. G. Wight 17215.*

Flint Island, copra plantation, alt. 2 m., Oct. 16, 1934, *St. John and Fosberg 17450.*

Usually found near present or former human habitations, this widespread plant is generally considered to have been introduced into Polynesia by the Polynesians in prehistoric times, and is still used extensively by them in medical practice.

Native names: *hora* on Anaa and Tepoto; *nonu* on Mangareva and many other islands.

Considerable variation is evident in the size and shape of the leaves, varying from broadly ovate or elliptical to broadly lanceolate. The length of the petiole varies some, also, as does the length of the peduncle, and the size and shape of the mature fruit.

BORRERIA

Borreria laevis (Lam.) Griseb.: Goett. Abh., **7**:231, 1857.

Spermococe laevis Lam.: Tab. Encycl. Meth. Bot., **1**:273, 1791.

Fanning Island: English Harbor, alt. 1 m., April 23, 1934, *St. John and Fosberg 14115.*

This weed species is evidently a comparatively recent arrival. Its recent occurrence in a number of widely separated islands in the western Pacific has been noted by Merrill (Philipp. Jour. Sci., **60**:34, 1936). It is generally considered to be a native of tropical America (fide Standley) but probably arrived in Fanning from some place farther west in the Pacific such as Samoa or Fiji where it is known. Determined by Dr. Paul Standley and Dr. E. D. Merrill.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV February 7, 1938 Number 1

An Open Bog on Oahu

Descriptions of two new varieties of Styphelia and Lobelia

By F. R. FOSBERG AND E. Y. HOSAKA

Open bogs form a peculiar and highly localized aspect of the Hawaiian vegetation, heretofore considered to occur only on the four highest islands of the Hawaiian group—Kauai, Molokai, Maui, and Hawaii. Rock[1] says that the bogs are usually confined to the summits of the mountains of the older islands or portions of islands, at an altitude of little over 1,500 meters, though they may be found also in the midst of the middle forest zone at about 1,200 meters; the well developed bog at Wahiawa, Kauai, is at 650 meters altitude. In general, bogs occur in very wet regions on mountain tops and exposed slopes and in more or less level openings in the forest.

Hawaiian bogs are characterized by an extremely dwarfed growth of the species represented in the surrounding forest, and by a number of species practically endemic to the bogs. Most of the plants are deeply embedded in cushions and hummocks of mosses, hepatics, and turf-forming grasses and sedges. The uniformly low growth is interrupted only by tall lobelias, up to 2 meters high, scattered here and there. The area is saturated with water and there are often channels and pools between the hummocks.

The most characteristic bog species in the Hawaiian islands are *Selaginella deflexa, Schizaea robusta, Oreobolus furcatus,* various dwarfed species of *Acaena, Geranium humile, Drosera longifolia, Panicum, Viola kauaiensis* and *V. mauiensis,* several species of *Sani-*

[1] Rock, J. F., The indigenous trees of the Hawaiian islands, pp. 75-79, Honolulu, 1913.

cula, Vaccinium pahalae, Styphelia Douglasii var. *struthioloides,* various forms of native *Plantago,* the group of species of *Lobelia* centering around *L. Kauaensis, Argyroxiphium Grayana* and *A. Caligini.* Certain of these are of general occurrence in most of the bogs, while others are endemic to bogs of one or two islands.

The more familiar bogs of the islands are those in Alakai Swamp, Kauai; Kawela Swamp, Molokai; Puu Kukui, west Maui; and Kaala Bog, Kohala Mountains, Hawaii. Heretofore open bogs, as described above, have not been known on Oahu.

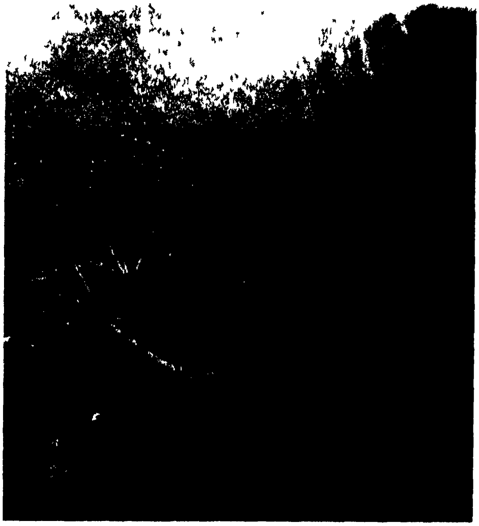

FIGURE 1.—Portion of the bog, showing *Lobelia Gaudichaudii* var. *koolauensis* in fruit.

The exposed, turfy crests of the Koolau Range, Oahu, show some resemblance to the open bogs, both floristically and physiognomically. The presence of a dwarf *Panicum* (*P. koolauense*), *Lobelia Gaudichaudii, Plantago pachyphylla, Sanicula purpurea,* and the dwarfing of the vegetation in general are significant in this respect. *Viola oahuensis* also, being more or less confined to this habitat, may almost be considered a bog species.

On May 31, 1937, the writers discovered a small area in the cloud zone (see Hosaka, B. P. Bishop Mus., Occ. Papers, vol. 13, no. 17, p. 206, 1937) at the head of Kaipaupau and Kawainui gulches,

Oahu, which, though lacking several of the common bog species, seems to have the floristic and physiognomic aspect of a true open bog (fig. 1). It lies on the brow of a bluff at the head of Kaipaupau Gulch on the summit of the Koolau Range in one of the wettest regions on Oahu, at an altitude of 850-860 meters. The actual bog area is about 25 meters square and slopes steeply at an angle of more than 45 degrees from the summit to the precipice below on the windward side. Winds, bearing rain-laden clouds, sweep the bog, apparently rather continuously. Both on our first visit and on a visit seven weeks later by F. R. Fosberg and Dr. Frank E. Egler the temperature was uncomfortably cold and seemed lower than in the surrounding forest. The water-saturated moss layer is from 3 to 6 decimeters thick, and sharply demarcated from the underlying, almost humus-free clay soil.

The following species are present which may be considered proper bog species: *Schizaea robusta, Panicum koolauense, Viola kauaiensis, Viola oahuensis, Vaccinium pahalae, Styphelia Tameiameiae* var. *hexamera, Sanicula purpurea,* and *Lobelia Gaudichaudii* var. *koolauensis. Peperomia ellipticibacca* is also a plant which seems to favor such situations. Of these, *Lobelia Gaudichaudii* var. *koolauensis* is a striking new variety with its closest relatives in the bogs of Kauai; and *Styphelia Tameiameiae* var. *hexamera* is a dwarf variety corresponding to *S. Douglasii* var. *struthioloides* of the bogs of other islands. These two new varieties are described below. Both are apparently confined to this one locality, extending slightly into the scrub surrounding the bog. *Viola kauaiensis* has not been reported previously outside the island of Kauai, where it is a conspicuous inhabitant of the bogs, and where it also occurs in a larger form in the forests. The specimens from Oahu correspond very well with the dwarf form from the bogs. *Vaccinium pahalae* has been previously known only from Hawaii and Molokai. The Oahu specimens check favorably with the form from the Molokai bogs, though they are very depauperate and sterile. *Schizaea robusta* here attains a remarkably large size, some of the fronds reaching at least 2 decimeters in height and arising from a heavy vertical rhizome almost as long, buried in the moss.

The following other species, found also in the surrounding forest, are present, most of them principally near the margins: *Hymenophyllum lanceolatum* (?), *Cibotium Chamissoi, Cibotium Menziesii,*

Gleichenia linearis, Sadleria Hillebrandii, Sadleria polystichoides, Stenoloma chinensis, Elaphoglossum gorgoneum (?), *Polypodium tamariscinum, Nephrolepis cordifolia, Lycopodium serratum, Lycopodium cernuum, Mariscus angustifolius, Isachne pallens, Eupritchardia* sp., *Anoectochilus* sp., *Peperomia latifolia, Broussaisia arguta, Pelea clusiaefolia, Metrosideros collina* var., *Metrosideros* sp. (aff. *rugosa*), *Cheirodendron platyphyllum* (two forms), *Vaccinium dentatum, Labordia* sp., *Nertera depressa, Scaevola glabra, Bidens macrocarpa.*

A number of mosses and hepatics, as well as algae, are present in profusion. The genus *Sphagnum* has not been found on Oahu.

Styphelia Tameiameiae (Cham. and Schlect.) F. Muell. var. **hexamera** Fosberg and Hosaka, n. var.

Planta depaupera, maxime 3 dm., flores 5-7 (usiter 6) meri.

Shrub up to 3 dm. tall, flowers usually 6-merous, rarely 5 or 7, corolla lobes 1.3-1.5 mm. long, tube 1.8-2.0 mm. long.

Oahu: Koolau Range, main divide above Kaipaupau Gulch, alt. 850 m., May 31, 1937, *Fosberg and Hosaka 13971* (type in Bishop Mus.); same locality and altitude, July 24, 1937, *Fosberg and Egler 14225.*

A dwarf form, possibly not worth describing, but the increased number of flower parts is unusual in the genus, 5 being the ordinary number.

Lobelia Gaudichaudii A. DC. var. **koolauensis** Hosaka and Fosberg, n. var. (fig. 2).

Plantae 1-1.5 m. altae, foliis 12-17 cm. longis 2-2 5 cm. latis lance-spathulatus, inflorescentiis 3-6 divisiis 40-50 cm. longis, pediculis 2.5-3.0 cm. longis, corolla 5.8-6.5 cm. longa, 1.8-2.0 cm. lata, alba vel alba-viridis.

Plants 1-1.5 m. tall, stem unbranched, 3-4 cm. in diameter, leaves clustered at apex of stem; leaves 12-17 cm. long, 2-2.5 cm. wide, glabrous, coriaceous; inflorescence branching candelabra-like, glabrous, the 3-6 stalks 40-50 cm. long, with 20-35 flowers, the stalks bracteate but leafless; floral bracts 2.5-3.0 cm long, 7-10 mm. wide, coriaceous, glabrous; pedicels 2.5-4.3 cm. long, glabrous; calyx tubes 8-11 mm. long, broadly obconical, glabrous, the lobes 10-15 mm. long, 3-6 mm. wide, lanceolate, glabrous; corolla 5.8-6.5 cm. long, 1.8-2.0 cm wide, whitish to whitish green, glabrous; staminal column glabrous; anthers glabrous, the tips all bearded; stigma 2-lobed, bearded.

Oahu: Koolau Range, divide between head of Kawainui Gulch and Kaipaupau Gulch, alt. 860 m., on open, windswept, sloping bog, June 1, 1937, *Hosaka and Fosberg 1915* (type in Bishop Mus.); same locality and altitude, July 24, 1937, *Fosberg and Egler 14224.*

This variety comes close to *Lobelia Gaudichaudii* and *L. kauaensis* but closer to the latter with similar branching inflorescence.

It differs from *L. Gaudichaudii* in having a branching inflorescence, whitish to whitish green corollas and staminal columns, gla-

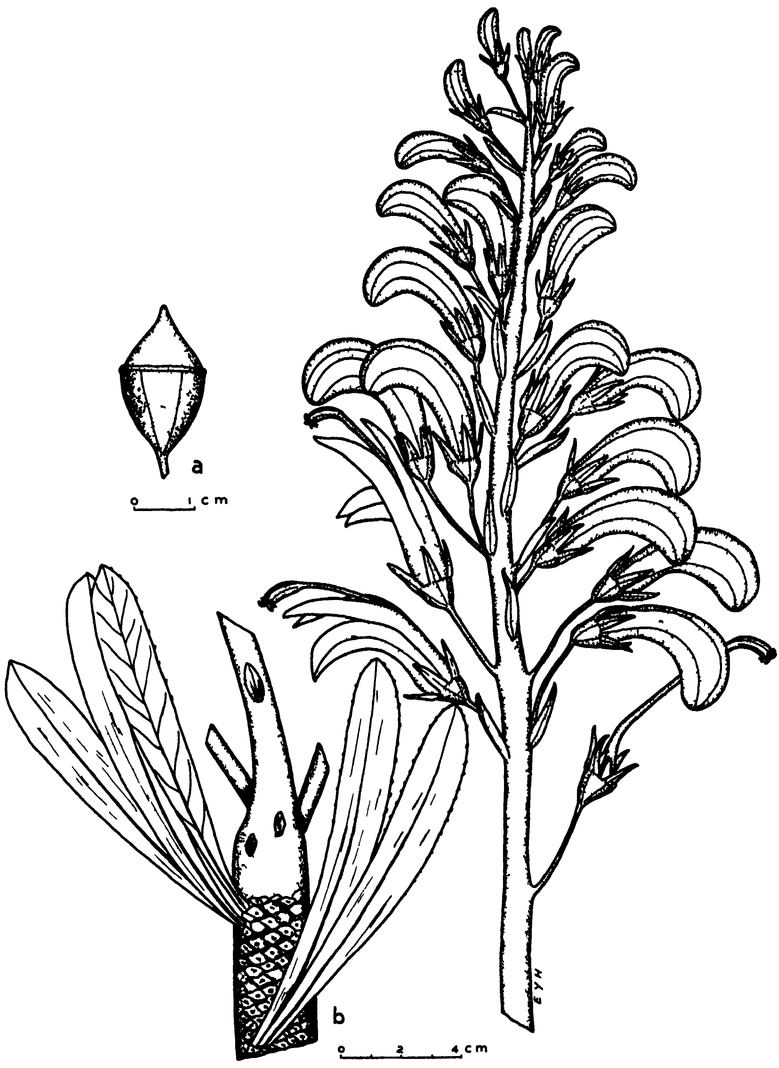

FIGURE 2.—*Lobelia Gaudichaudii* var. *koolauensis*: *a*, capsule, *b*, upper part of stem.

brous and softer textured leaves, and broader flowers, 1.8-2.0 cm. wide. *L. Gaudichaudii* has simple inflorescence (rarely branched), deep red-purplish corollas and staminal columns, thick leaves commonly with pubescent midribs and basal ciliate margin, smaller flowers, 7-10 mm. wide.

It differs from *L. kauaensis* in having longer pedicels, 2.5-4.3 cm. long, larger flowers, 5.8-6.5 cm. long, 1.8-2.0 cm. wide, whitish to whitish green corollas, and having no leaves on flower-stalks. *L. kauaensis* has pedicels 2.0-2.8 cm. long, smaller flowers, 4-6 cm. long, 1 cm. wide, with deep purplish streaks, and with leaves on flower-stalks.

The differences seem slight but the variety can be very easily recognized in the field and with herbarium specimens. *Lobelia kauaensis* is found only on the island of Kauai in summit bogs, *L. Gaudichaudii* on Oahu and Molokai (?), and *L. Gaudichaudii* var. *koolauensis* only in a small bog, about 25 meters square, on the summit ridge of the Koolau Range, Oahu, from which the variety takes its name.

The flowering period of this new variety is different from that of any species of Hawaiian *Lobelia,* all of which flower between August and December; this new variety flowers from May to July. There were about 15-20 matured plants in the area in June and July and these were all in some stage of flowering. The flowering periods of the Hawaiian species of Campanulaceae are quite definite.

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV March 31, 1938 Number 2

Revision of the Micronesian Species of Peperomia

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Micronesia as defined here includes those islands in the western part of the Pacific Ocean lying north and east of New Guinea and the Philippines and, for the most part, are included in the Marianas, Caroline and Marshall groups. Many of the islands in this area are low, arid, and unsuited to *Peperomia,* most species of which prefer moist, shady situations in the forests and ravines of more or less mountainous regions. Some of the islands, however, are sufficiently high to have conditions favorable for their development.

The earliest reference which I have found to any Micronesian species is given by Miquel (Systema Piperacearum, 120, 1843) who refers a specimen collected by Gaudichaud in the Marianas Islands to *Peperomia membranacea* Hooker and Arnott. Later C. de Candolle [Prodromus, **16**(1): 442, 1869] correctly pointed out that a specimen collected by Gaudichaud, and which he believed to be the same as that cited by Miquel, was not the same as Hooker and Arnott's *P. membranacea* and described it as new under the name *P. mariannensis.* In 1914 Merrill published "An enumeration of the plants of Guam" (Philippine Jour. Sci., **9**: 72, 1914) in which De Candolle contributed the descriptions of two new species from the Marianas group: *P. guamana* from a specimen collected by McGregor on Guam, and *P. saipana* from one obtained by Fritz on the near-by island of Saipan. In 1921 De Candolle (Engler Bot. Jahrb., **56**: 503 ff., 1921) described eight additional new species from specimens which had been obtained by collectors in different parts of Micronesia. In 1936 Hosokawa (Nat. Hist. Soc. Formosa, Trans., **25**:119, 1936) gave a summary of

the Micronesian species and added the descriptions of three species new to science.

Of those species which have been previously recorded, ten are recognized in the present paper as being valid while one has been reduced to varietal rank. To these are now added *P. pellucida,* an American species of wide distribution in the tropics, *P. leptostachya,* a common species throughout Polynesia, and one species here described as new, thus making a total of thirteen species and one variety as recognized for Micronesia.

Additional small collections of *Peperomia* have recently been made by E. H. Bryan Jr. in Guam, by R. Kanehira in the Marianas and the Carolines, and by M. Takamatzu in the Carolines. Micronesian materials of the genus are meager in American and European herbaria, however, and it is believed that additional species will be discovered after more extensive botanical exploration, especially on the larger islands.

The types of all of the species are deposited in European herbaria with the exception of Hosokawa's which are in the herbarium of the Taihoku Imperial University at Taiwan. I have been unable to locate any duplicates of his specimens in other herbaria nor have I been able to study the specimens at Taiwan. It is very difficult to recognize many species of *Peperomia* without authentic material or photographs for comparison. For this reason it has not been possible to identify Hosokawa's species with any degree of certainty.

With the exception of *P. pellucida,* the species all agree in having the stigmas placed slightly subapically, but the apex of the fruit is not as definitely oblique as is characteristic of many of the Hawaiian and southeastern Polynesian species. In this character they more closely resemble the fruit of some of the Malaysian species. The arrangement of the leaves is indefinite with several of the species having both opposite and alternate leaves on the same stem. No specimens seen, however, have more than two leaves at a node.

Specimens from which this study was made were loaned by the herbaria of the Berlin Museum, B. P. Bishop Museum, Kew Gardens, New York Botanical Garden, and the United States National Museum. Several additional herbaria reported that they had no material from Micronesia. I wish to express my appreciation to the directors of these institutions for their courtesies in making the specimens available for study.

Key to the Species

1. Leaves ovate-cordate, fruit longitudinally ribbed **1. P. pellucida**
Leaves never cordate, fruit more or less verrucose but not longitudinally ribbed 2
2. Stems glabrous 3
Stems more or less hairy 8
3. Stigmas bilobulate, pilose when young **2. P. Gibbonsii**
Stigmas not bilobulate 4
4. Leaves less than 2 cm long, more or less ovate, plants more or less repent **3. P. Kraemeri**
Leaves mostly 2.5-4 cm long, elliptic or oval to obovate 5
5. Leaves obtuse or subacute 6
Leaves mostly acute, plants about 15 cm. in height **4. P. guamana**
6. Leaves elliptic-ovate, base obtuse **5. P. mariannensis**
Leaves elliptic to obovate, base acute to cuneate 7
7. Leaves predominatingly opposite **6. P. Volkensii**
Leaves predominatingly alternate **7. P. ponapensis**
8. Stems sparsely hairy to glabrate **4. P. guamana** variety **saipana**
Stems moderately to densely hirtellous or hirsute 9
9. Rachis more or less hairy, leaves more or less elliptic, 1.5-2.5 times as long as wide **8. P. palauensis**
Rachis glabrous, leaves suborbicular or subovate to oval or subobovate, mostly less than 1.5 times as long as wide 10
10. Leaves opposite or verticillate, spikes much longer than the leaves **9. P. leptostachya**
Leaves mostly alternate 11
11. Leaves mostly 2 cm or less in length, the spikes about equaling the length of the leaf blade **10. P. breviramula**
Leaves mostly 2 cm or more in length 12
12. Leaves mostly 2-3 × 3-4.5 cm, spikes 1.5-2 times as long as the leaf blades **11. P. trukensis**
Leaves 1.5-2 × 2.5-3 cm, spikes not exceeding the leaves 13
13. Spikes as long as the leaf blades **12. P. kusaiensis**
Spikes shorter than the leaf blades **13. P. pacifica**

1. **Peperomia pellucida** (Linnaeus) Humboldt, Bonpland, and Kunth.

Peperomia pellucida (Linnaeus) Humboldt, Bonpland, and Kunth, Nov. Gen. Sp. Pl., **1**:64, 1815; Dahlstedt, Kongl. Sv. Vet. Akad., Handl., **33**(2):16, tab. 1, fig. 1, 1900; Quisumbing, Philippine Jour. Sci., **43**: 218, fig. 117, 1930.

Piper pellucidum Linnaeus, Sp. Pl., 30, 1753.

Peperomia yapensis C. de Candolle, in Engler's Bot. Jahrb., **56**:504, 1921.

This is a common American species which has become widely distributed throughout the Pacific area. Some of the plants which I have seen from the Pacific are considerably smaller than most of

the American specimens but other than the difference in size they appear to be the same. *P. pellucida* variety *pygmaea* Willdenow herb. no. 725a, (Kunth Synops., 1:117, 1822, ex Miquel, Syst. Pip., 81, 1843) appears from the description to differ from *P. pellucida* mainly in the smaller size of the plants. Some colonies of *P. pellucida* which I have observed and collected in Central America contained plants exhibiting a wide range in size, and some of the smallest could well represent variety *pygmaea.* I have not seen the type of this variety but from the specimens which I have studied I do not believe that any of the small Micronesian plants are worthy of varietal distinction, and from the evidence at hand I am inclined to interpret the size of the specimens as due to environmental factors.

Caroline Islands: Yap Island, "in dem Moospolster am Fuss einer Kokospalme," January 9, 1900, *G. Volkens 343* (type of *P. yapensis*, Berlin); Kanif, in shaded place in forest, May 16, 1936, *M. Takamatsu 1910* (Bishop Mus.); Kusaie Island, Lele, on shaded rock or ground, January 30, 1936, *M. Takamatsu 332* (Bishop Mus.); Palau Islands, Koror, 20-40 meters altitude, February 9, 1914, *Ledermann 14129* (Berlin; Kew). This specimen is normal size for the species.

Marianas Islands: Guam, Guam Experiment Station, collected under direction of J. B. Thompson, *234* (Berlin; Kew; N. Y.; U. S. Nat.); *H. L. W. Costenoble 1197* (U. S. Nat.).

2. **Peperomia Gibbonsii** C. de Candolle (fig. 1).

Peperomia Gibbonsii C. de Candolle, in Engler's Bot. Jahrb., **56**:504, 1921.

Spike-bearing branches erect, up to 13 cm. high and 2 mm. thick when dry, dichotomously or trichotomously branching, glabrous, the internodes up to 5 cm. long below. Leaves alternate or more rarely opposite at the upper nodes, up to 1.5 cm. wide and 3 cm. long, glabrous, ciliated near the apex with minute hairs, lanceolate-obovate, apex briefly attenuated, acutish, base acute, veins 5, palmate, the petioles 4 to 6 mm. long, glabrous. Spikes axillary and terminal, single or commonly in umbellate clusters of two or three spikes, or in the axils of small leaf-like bracts forming a loosely branching inflorescence, up to 4 cm. long, moderately to densely flowered, the peduncles up to 1 cm. long, glabrous, the rachis glabrous, the bracts round-peltate, about 0.5 mm. in diameter, punctate with yellow dots, the filaments about equaling the ellipsoidal anthers, the ovary ovoid, apex oblique, stigma divided to form two fleshy, pilose pads, the fruit about 0.8 mm. long, globose-ovoid, verrucose, viscid, eventually on pseudopedicels.

Marshall Islands: "Ailinlaplap [Ailinglapalap?], in der Mitte der Insel auf Steinigem Basaltboden, in Schatten von Kokospalmen," February 26, *C. Gibbons 1072* (type, Berlin).

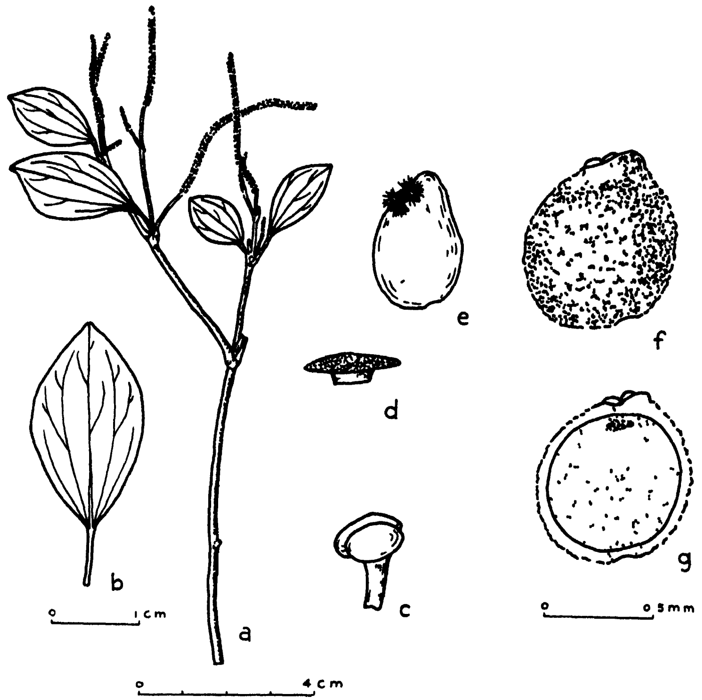

FIGURE 1.—*Peperomia Gibbonsii* C. de Candolle. *a,* plant; *b,* leaf; *c,* stamen, enlarged; *d,* bract, enlarged; *e,* ovary, enlarged; *f,* fruit; *g,* section of fruit.

The bilobulate stigmas and spike arrangement distinguish this species. None of the several plants on the type sheet have the lower rooting part present, and as only the one collection of this species was seen it has been impossible to determine the characteristics of the basal part of the plants. The specimens, also, have only a few leaves present but I am unable to determine whether this indicates a natural loss of the leaves or not. The only species which I have observed from the Pacific area that readily loses its leaves, especially during the drying process, is *P. leptostachya.* It is not unusual to find herbarium specimens of that species entirely devoid of leaves and I have also observed some old plants in the field in which many of the leaves

had fallen. Most species, however, retain most of their leaves even on herbarium sheets; if the more or less leafless condition of the type specimen of *P. Gibbonsii* is natural it is significant.

3. **Peperomia Kraemeri** C. de Candolle (fig. 2).

Peperomia Kraemeri C. de Candolle, in Engler's Bot. Jahrb., **56**: 503, 1921.

Peperomia tiniannensis Hosokawa mss., ex Hosokawa, Nat. Hist. Soc. Formosa., Trans., **25**:121, 1935.

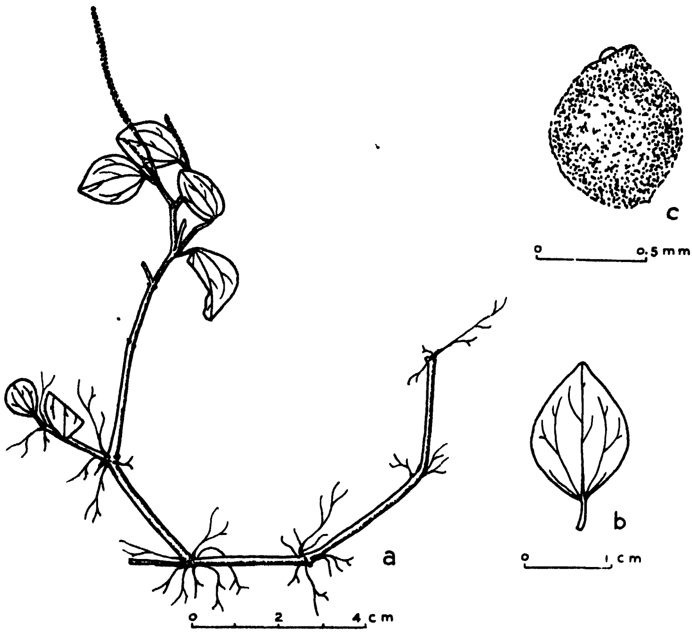

FIGURE 2.—*Peperomia Kraemeri* C. de Candolle: *a*, plant; *b*, leaf; *c*, semi-mature fruit.

Stems decumbent and rooting at the nodes, leafy, spike-bearing branches arising up to 8 cm. high, 2 mm. thick near the base when dry, glabrous, branching, the internodes 1 cm. long above, up to 3 cm. long below. Leaves mostly alternate, some lower leaves opposite, 1 to 1.3 cm. wide and 1.5 to 2 cm. long, the upper surface dark, sparingly puberulent at the base and more or less upward along the veins and near the margin at the apex, the lower surface lighter, glabrous, marginally ciliated near the apex, oval-ovate, apex obtuse to somewhat acutish, base acute, veins 3 or 5, palmate, the petioles about 3 mm. long, glabrous. Spikes terminal or opposite the upper leaves, 3.3 cm. long, moderately to densely flowered, the peduncle about 1 cm. long, glabrous, the rachis glabrous, the bracts round-peltate, about 0.5 mm. wide, punctate with yellow dots, the

filaments somewhat longer than the ellipsoidal anthers, the ovary ovoid, apex oblique, stigma subapical, the fruit about 0 8 mm. long, subglobose, verrucose, viscid.

Caroline Islands: Palau Islands, Koror, *Kraemer* (type, Berlin).

The type of this species, the only specimen which I have seen, is poor and it is probable that with more abundant material the description will need some modification. The size and shape of the leaves and the presence of hairs on the upper surface distinguish it from the other Micronesian species. Hosokawa's description and measurements of the leaves, etc., do not agree entirely with those of De Candolle nor with the type specimen which makes one suspect that his specimens, collected in the Marianas Islands, may be different, though he considered his name *P. tinniannensis* as synonymous with *P. Kraemeri.*

4. **Peperomia guamana** C. de Candolle (fig. 3).

Peperomia guamana C. de Candolle, Philippine Jour. Sci. **9**:72, 1914.

Peperomia Hoeferi C. de Candolle, in Engler's Bot. Jahrb., **55**:505, 1921.

? *Peperomia mariannensis* Hosokawa, Nat. Hist. Soc. Formosa, Trans., **25**:120, 1935.

Plants terrestrial or epiphytic. Stems erect or ascending up to 15 cm. or more high from a short decumbent base, rooting from the lower nodes, about 2 mm. thick near the base when dry, simple or commonly branching, glabrous, the internodes mostly from 1 cm. long above up to 3.5 cm. below or more rarely up to 5 cm. Leaves alternate but not uncommonly some leaves opposite, drying membranous, glabrous, not ciliated or with a few minute hairs at the extreme apex, elliptic-lanceolate to oval or more rarely subobovate, 1.2 to 2.5 cm. wide and 2 to 4.5 cm. long, but mostly 1.5 to 2 cm. wide and 2 to 3.5 cm. long, veins 3 or 5, palmate, when 5-veined the outermost pair indistinct and short, the midrib and innermost pair of lateral veins prominent and more or less impressed above, apex acute or in lower leaves obtusish, base acute to cuneate, the petioles glabrous, 5 to 8 mm. long, leaf scar semicircular. Spikes terminal or opposite the upper leaves, or more rarely axillary, up to 6 cm. long, mostly 3 to 5 cm. long, the peduncles glabrous, 5 to 8 mm. long, the rachis glabrous, the bracts round-peltate, about 0.4 mm. wide, the filaments somewhat longer than the ellipsoidal anthers, the ovary obovoid, apex oblique, stigma subapical, smooth or pilose, the fruit about 0.9 mm. long, globose-ovoid, verrucose, viscid, eventually on pseudopedicels.

Marianas Islands, Guam: *R. C. McGregor 629* (type number, U. S. Nat.); *H. L. W. Costenoble 1196* (U. S. Nat.); *P. Nelson 13* (U. S. Nat.); Talofofo Point, on a rock in moist lower forest, alti-

tude 90 meters, April 11, 1936, *E. H. Bryan Jr. 1116* (Bishop Mus.; N. Y.); on a rock on the north side of Talofofo valley, about half a mile from sea, altitude 10 meters, April 1, 1936, *E. H. Bryan Jr. 1044* (Bishop Mus.); Ritidian Point, on rocks in trail to lighthouse, altitude 190 meters, April 16, 1936, *E. H. Bryan Jr. 1174* (Bishop Mus.); on rocks on limestone slope, under moist forest, altitude 50 to 150 meters, April 16, 1936, *E. H. Bryan Jr. 1156* (Bishop Mus.); Machanao District, on rocks and tree trunks in moist limestone forest, altitude 110 meters, April 16, 1936, *E. H. Bryan Jr. 1187* (Bishop Mus.); Upi (N. E. point) on rocks in moist limestone forest, altitude 175 meters, May 5, 1936, *E. H. Bryan Jr. 1265* (Bishop Mus.).

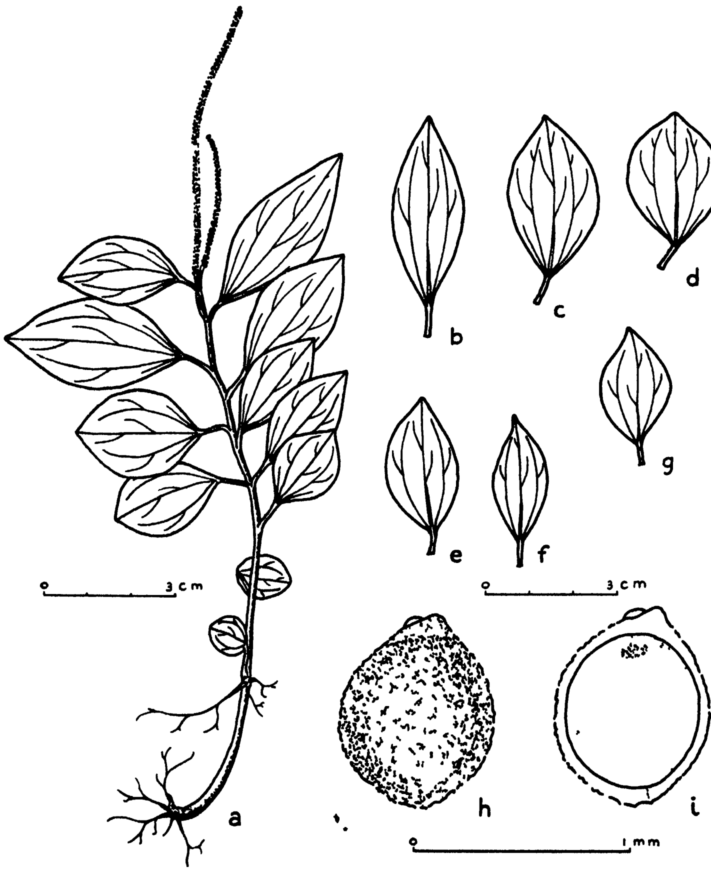

FIGURE 3.—*Peperomia guamana* C. de Candolle: *a,* plant; *b-g,* leaves, showing variation in size and shape; *h,* fruit; *i,* section of fruit.

Saipan: on limestone, February 13, 1903, *Hoefer 38* (type of *P. Hoeferi,* Berlin).

Peperomia guamana C. de Candolle variety **saipana** (C. de Candolle), new combination.

Peperomia saipana C. de Candolle, in Engler's Bot. Jahrb., **56**: 505, 1921.

Stems sparingly hirtellous. Leaves marginally ciliated at least when young.

Marianas Islands: Saipan, 1903, *Fritz* (type of *P. saipana,* Berlin).

Peperomia Hoeferi was distinguished by De Candolle as having apical stigmas and opposite leaves whereas he described *P. guamana* as with alternate leaves and subapical stigmas. On specimens of the type number of *P. guamana* leaves are both alternately and oppositely arranged. In other collections, believed to be of the same species, some plants have most of the leaves opposite while others may be predominatingly alternate. I also find on the type specimen of *P. Hoeferi* both alternate and opposite leaves. I likewise find the stigmas to be subapical on the types of both species.

In describing his *P. mariannensis* as a new species Hosokawa evidently overlooked the fact that De Candolle had previously given this name to a species in 1869. In his key Hosokawa uses the presence or absence of hairs on the stigmas as a primary character in separating his *P. mariannensis* from *P. guamana.* While this character is of some value under ideal conditions, I have found that the hairs are often early deciduous and easily lost and hence I do not believe that it has much value when used alone in distinguishing species from dry herbarium specimens. From Hosokawa's description I am unable to distinguish his species from some of the specimens I am including here.

De Candolle described the stigma as apical in *P. saipana* but I find it to be subapical as in *P. guamana.* Other than the presence of hairs, I am unable to distinguish the type specimen of *P. saipana,* which is fragmentary and the only one which I have examined, from *P. guamana.*

5. **Peperomia mariannensis** C. de Candolle (fig. 4).

Peperomia mariannensis C. de Candolle, Prodromus **16**:(1): 442, 1869.

Stems ascending from a decumbent (?), rooting base, up to 12 cm. high, 2 mm. thick near the base when dry, glabrous, the internodes up to 3.5 cm. long. Leaves opposite, up to 2 cm. wide and 3.5 cm. long, glabrous, not ciliated or with a tuft of minute hairs at the very apex, drying thin and membranous, elliptic-ovate, apex obtuse, base obtuse, veins 5, palmate, the petioles up to 6 mm. long, glabrous. Spikes terminal, 3 cm. long, moderately flowered, the peduncle 5 mm. long, glabrous, the rachis glabrous, the bracts about 0.5 mm. wide, round-peltate, the filaments about equal to the ellipsoidal anthers, the ovary obovoid, apex oblique, stigma subapical, the fruit not matured.

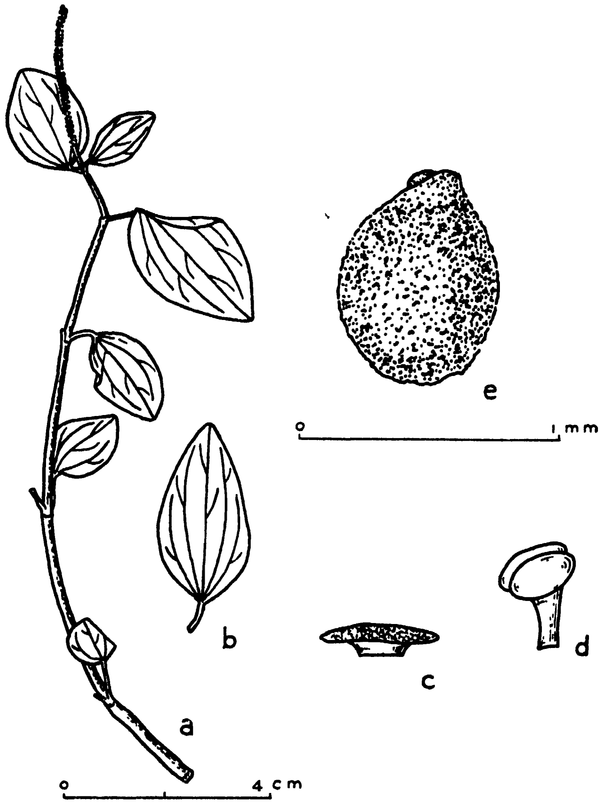

FIGURE 4.—*Peperomia mariannensis* C. de Candolle: *a,* plant; *b,* leaf; *c,* bract, enlarged; *d,* stamen, enlarged; *e,* fruit.

Marianas Islands: *Gaudichaud* (type, Berlin).

The type of this species is fragmentary. It appears to be closely related to *P. guamana* but the single specimen studied differs from those specimens which I refer to *P. guamana* mainly because of the

obtuse apex and base of the leaves. The leaves also are opposite but whether this character is constant or not can be determined only by the examination of more abundant materials. The specimen upon which this species is based may be the one which Miquel referred to *P. membranacea* Hooker and Arnott.

6. **Peperomia Volkensii** C. de Candolle (fig. 5).
Peperomia Volkensii C. de Candolle, in Engler's Bot. Jahrb., **56**: 503, 1921.

Stems ascending up to 15 cm. or more high from a decumbent, rooting base, up to 3 mm. thick when dry, abundantly branching, glabrous, the internodes from 1.5 cm. long above up to 7 cm. long below. Leaves opposite or rarely alternate, up to 2.6 cm. wide and 4 cm. long, mostly 1.5 to 2 cm. wide and 2.5 to 3.3 cm. long, drying pale and moderately membranous, glabrous on both surfaces, not ciliated or with a few minute hairs at the very apex, elliptical to oval-obovate, apex shortly attenuated, obtuse, base acute to subcuneate, palmately 3-veined or larger leaves 5-veined with the outermost pair of veins inconspicuous, the petioles 5 to 10 mm. long, glabrous. Spikes terminal and axillary, numerous, up to 4.3 cm. long but mostly about 3 cm. long, the peduncle about 1 cm. long, glabrous, the rachis glabrous, bracts round-peltate, about 0.5 mm. in diameter, the filaments about equal to the ellipsoidal anthers, the ovary obovoid, apex oblique, stigma subapical, pilose, the fruit about 0.9 mm. long, ovoid, verrucose, viscid.

Caroline Islands: "Auf Mauern in Lele bei Kussai" (Kusaie), October 9, 1899, *G. Volkens 2* (type, Berlin).

7. **Peperomia ponapensis** C. de Candolle (fig. 6).
Peperomia ponapensis C. de Candolle, in Engler's Bot. Jahrb., **56**: 504, 1921.

Stems ascending up to 30 cm. or more high from a decumbent base, rooting from the lower nodes, 3 mm. thick near the base when dry, branching abundantly, glabrous, the internodes 1.5 to 6 cm. long. Leaves alternate or more rarely opposite, glabrous, not ciliated or with a few short hairs at the extreme apex, obovate to oval-obovate, mostly 2 to 2.8 cm. wide and 3 to 5 cm. long, veins 5, palmate, apex shortly attenuated, obtuse, base acute to cuneate, the petioles 5 to 9 mm. long or the lower leaves with petioles up to 1.5 cm. long, glabrous. Spikes terminal or opposite the upper leaves, up to 7 cm. long, moderately flowered, the peduncles 0.8 to 1.5 cm. long, glabrous, the rachis glabrous, the bracts round-peltate, about 0.5 mm. wide, the filaments about equal to the ellipsoidal anthers, the ovary globose to obovoid, apex oblique, stigma subapical, pilose or smooth, the fruit about 0.8 mm. long, globose-ovoid, verrucose, viscid, eventually on pseudopedicels.

Caroline Islands: Ponape, Nanmatal, Kalau-Buschwald auf den Ruinen der alten Stadt, auf den Basaltblocken der Ruine, January 8, 1914, *Ledermann 13984* (De Candolle cited this number in error as

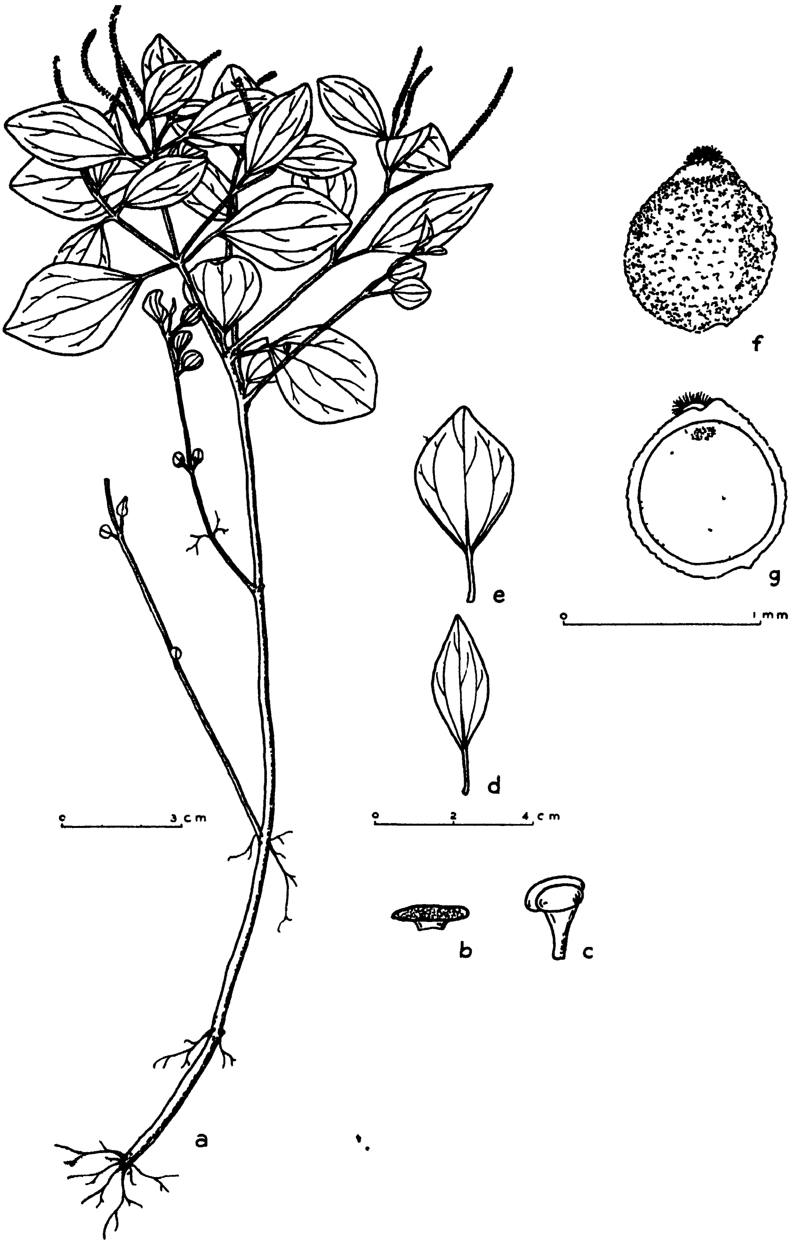

FIGURE 5—*Peperomia Volkensii* C. de Candolle: *a,* plant; *b,* bract, enlarged; *c,* stamen, enlarged; *d-e,* leaves; *f,* fruit; *g,* section of fruit.

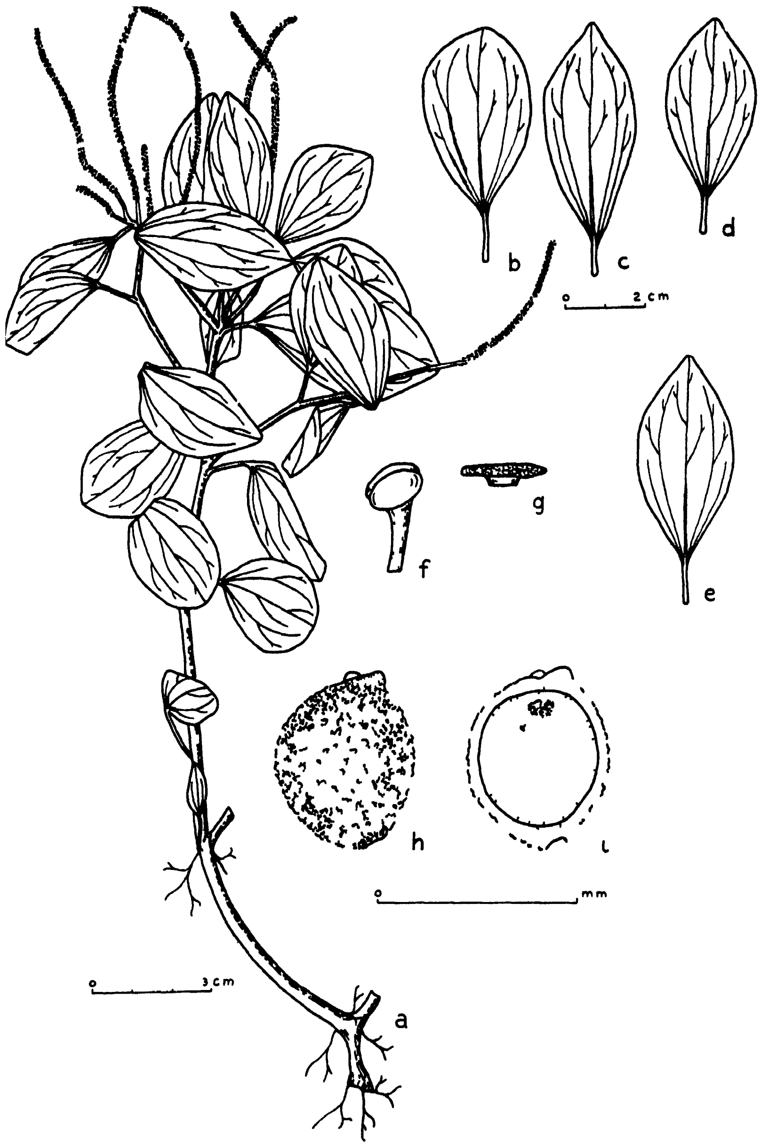

FIGURE 6—*Peperomia ponapensis* C de Candolle *a*, plant, *b e*, leaves, showing variation in size and shape, *f* stamen, enlarged, *g*, bract, enlarged, *h*, fruit, *ι*, section of fruit

13914) (type, Berlin; Kew); in strand, August 16, 1929, *R. Kanehira 858* (N. Y.). The leaves of this specimen are somewhat smaller than those on the type specimen.

Marianas Islands: Saligan, July 5, 1933, *R. Kanehira 2171* (N. Y.). This is a sterile and poorly prepared specimen with leaves smaller than those of the type. It agrees sufficiently well, however, in the characters which are present to warrant placing it here. Saipan, *R. Kanehira 986* (N. Y.). This is likewise a poorly prepared specimen with the leaves mostly 2 to 3 cm. long. Although these specimens seem to agree best with *P. ponapensis,* it is possible that with more abundant and better prepared materials these small-leaved forms may be found to be distinct.

8. **Peperomia palauensis** C. de Candolle (fig. 7).

Peperomia palauensis C. de Candolle, in Engler's Bot. Jahrb., **56**: 505, 1921.

Stems slender, repent, branching, rooting at the nodes, up to 2 mm. thick when dry, leafy branches ascending up to 10 cm. or more high, moderately to densely hirtellous, hairs subappressed, less than 0.5 mm. long, the internodes up to 5 cm. long, mostly 1 to 2 cm. long in the leafy branches. Leaves alternate or rarely opposite, dark above, lighter beneath, drying thin and membranous, both surfaces sparsely hirtellous to glabrescent, more or less ciliated with hairs up to 0.5 mm. long, some leaves completely so, others ciliated only at the apex, elliptic-lanceolate or more rarely oval, some lower leaves obovate to suborbicular, the upper leaves mostly 2 to 3.2 cm. long and 0.8 to 1.5 cm. or rarely up to 1.9 cm. wide, the lower leaves commonly much smaller, veins 3, palmate, or the larger leaves 5-veined, apex acute to obtusish, base acute, the petioles hirtellous, mostly 2 to 5 mm. or rarely up to 1 cm. long. Spikes terminal or opposite the upper leaves, up to 7 cm. long, the peduncle hirtellous, about 1 cm. long, the rachis sparingly hirtellous at least toward the base, less so above, the bracts round-peltate, about 0.5 mm. wide, punctate with yellow dots, the filaments about equal to the ellipsoidal anthers, the ovary obovoid, apex oblique, stigma slightly subapical, the fruit about 0.8 mm. long, ovoid, verrucose, viscid, stigma slightly subapical.

Caroline Islands, Palau Islands: Koror, 10-100 meters altitude, auf Kalkfelsen, February 7, 1914, *Ledermann 14102* (type, Berlin; Kew); Ponape, Sankaku-Yama, in forest at low altitude, August 12, 1929, *R. Kanehira 756* (N. Y.); *Ledermann 13175* (Kew); Tolomail, in forest, common, February 11, 1936, *M. Takamatsu 981, 986* (Bishop Mus.).

This species bears some resemblance to *P. huahinensis* Yuncker of the Society Islands but differs chiefly in its more slender stems

and in the character and abundance of the hairs. It also resembles *P. Elmeri* C. de Candolle of the Philippines but differs in the smaller size of the plants, smaller and more hairy leaves, etc. The rather slender, hirtellous, repent stems, and especially the more or less hirtellous rachis distinguish this from the other Micronesian species.

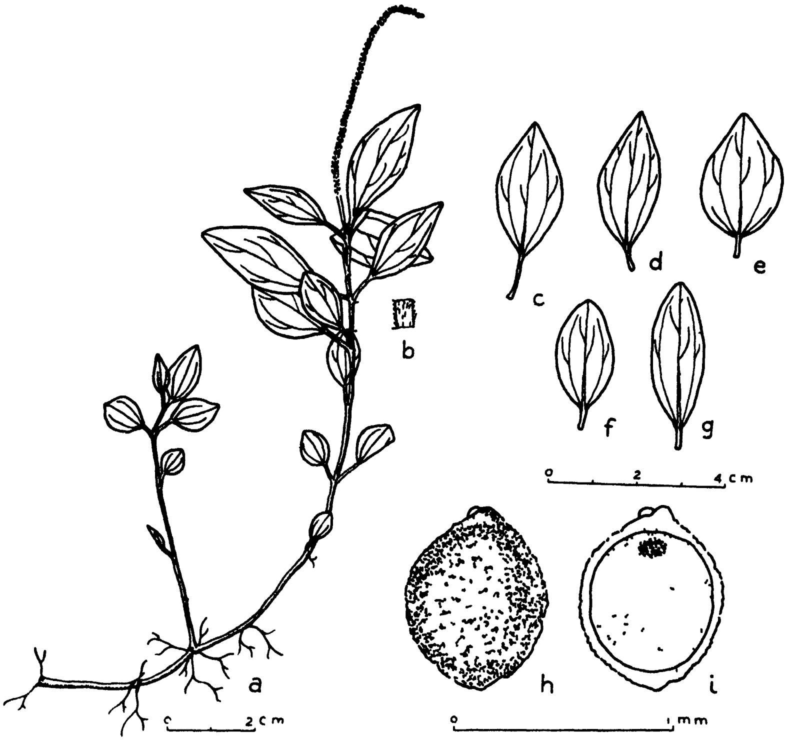

FIGURE 7—*Peperomia palauensis* C. de Candolle: *a,* plant; *b,* section of stem, enlarged; *c-g,* leaves, showing variation in size and shape; *h,* fruit; *i* section of fruit.

The hirtellous condition of the rachis is very evident on the type which is of ample material and with well developed spikes The other specimens included here have only immature spikes or lack them entirely so that the presence or absence of hairs on the rachis cannot be determined, but they agree very well in their vegetative characteristics. The amount of ciliation varies considerably, with the type showing the least of any of the specimens cited.

9. Peperomia leptostachya Hooker and Arnott.

Peperomia leptostachya Hooker and Arnott, Bot. Beechey, 96, 1832; Yuncker, B. P. Bishop Mus., Bull. **112**, 57, fig. 16, 1933.

This species is characterized by having more or less densely hirtellous stems and leaves which are opposite or verticillately arranged. It is very abundant in the Hawaiian islands (B. P. Bishop Mus., Bull. **112**, 57, 1933), and is the commonest and most widely distributed species throughout southeastern Polynesia (B. P. Bishop Mus., Bull. **143**, 58, 1937). It is apparently uncommon in the Fijian group (B. P. Bishop Mus., Bull. **141**, 46, 1936) and has not been found in the Philippines, according to Quisumbing [Philippine Jour. Sci., **43**(1), 1930].

The only specimen of this species from Micronesia which I have seen is one collected by R. Kanehira (no. 243, July 9, 1929) on an unnamed island near Corol [Koror] in the Pelew [Palau] group and now in the herbarium of the New York Botanical Garden. This specimen is not well preserved but it exhibits opposite and characteristically shaped leaves with the typical hairiness of *P. leptostachya.* The internodes are somewhat longer than is common for that species but it agrees sufficiently well in other characters to warrant reference to it. Furthermore, it was found growing on a coral reef near the sea, a situation common for *P. leptostachya* which is frequently found growing at lower altitudes and in more exposed localities that those tolerated by other species. The varieties *pilosior* and *longispica* of *P. recurvata* (Blume) Miquel from the Philippines closely resemble *P. leptostachya* in many respects.

10. Peperomia breviramula C. de Candolle (fig. 8).

Peperomia breviramula C. de Candolle, in Engler's Bot. Jahrb., **56**: 503, 1921.

Epiphytic. Stems decumbent and stoloniferous, rooting from the lower nodes, frequently branching, leafy branches ascending up to 8 cm. high, 1.5 mm. thick near the base when dry, abundantly subappressed hirtellous, hairs less than 0.5 mm. long, the internodes mostly 1 to 2 cm. long. Leaves alternate, moderately hirtellous on both surfaces when young, becoming more or less glabrate when older, abundantly ciliated, oval-elliptic to subovate or suborbicular, more or less rhombic, up to 1.6 cm. wide and 2.2 cm. long, mostly 1 to 1.4 cm. wide and 1.5 to 1.8 cm. long, veins 3, palmate, white beneath in dry specimens, apex obtuse, rounded or shortly attenuated, base acute or obtusish, the petioles mostly 3 to 5 mm. long, hirtellous. Spikes 1 to 1.8 cm. long, terminal or opposite the upper leaves, moderately flowered, the peduncles 5 to 9 mm.

long, hirtellous, rachis glabrous, the bracts round-peltate, about 0.5 mm. wide, punctate with yellow dots, the filaments about equal to the ellipsoidal anthers, the ovary obovoid, apex oblique, stigma subapical, the fruit about 0.8 mm. long, globose-ovoid, verrucose, viscid, eventually on pseudopedicels.

Caroline Islands: Ponape, Paue, Montesanto, 7-800 meters altitude, December 14, 1913, *Ledermann 13739* (type, Berlin; Kew).

The small plants, shape and size of the leaves, and short spikes distinguish this from the other Micronesian species.

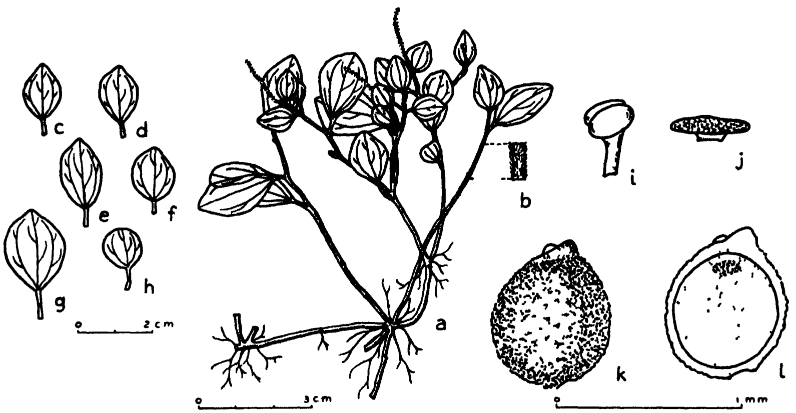

FIGURE 8.—*Peperomia brevramula* C. de Candolle: *a,* plant; *b,* section of stem, enlarged; *c-h,* leaves, showing variation in size and shape; *i,* stamen, enlarged; *j,* bract, enlarged; *k,* fruit; *l,* section of fruit.

11. **Peperomia trukensis,** new species (fig. 9).

Caules adscendentes usque ad 15 + cm. alti, ramosi, modice hirtelli, pilis fuscis, usque ad 0.5 mm. longis, internodis usque ad 4 cm. longis, plerumque 1-2 cm. Folia alterna, supra modice ad sparse hirtelli aut glabra, subter modice hirtelli, ciliata, ovala, usque ad 3.5 cm. lata et 5 cm. longa, plerumque 2-3 cm. lata et 3.5-4.5 cm. longa, palmatim 3- aut 5-nervia, apice subattenuata, obtuso aut subacuto, basi acuta, petiolo 0.8-1.2 cm. longo, hirtelli. Spicae terminales aut supra folio-opposita, usque ad 6 cm. longae, pedunculo usque ad 1.5 cm. longo, hirtello, ovarium obovoideum, apice obliquo, stigmate subapice; fructus circiter 0.8 mm. longus, globosus.

Stems ascending up to 15 cm. or more high from a decumbent base, rooting at the lower nodes, 3 mm. thick near the base when dry, branching, moderately hirtellous, hairs fuscous, up to 0.5 mm. long, the internodes mostly 1 to 2 cm. long, or the lower internodes up to 4 cm. Leaves alternate, drying thin and membranous, the upper surface dark colored and moderately to sparsely hirtellous or glabrate, the lower surface lighter and moderately hirtellous, ciliated at least above the middle, oval, up to 3 5 cm. wide and 5 cm. long, mostly 2 to 3 cm. wide and 3.5 to 4.5 cm. long, veins 3 or 5, palmate, when 5-veined the

outermost pair of veins slender and inconspicuous, apex subattenuate, obtuse or acutish, base acute, the petioles 0.8 to 1.2 cm. long, hirtellous. Spikes terminal or opposite the upper leaves, up to 6 cm. long, densely flowered, the peduncles hirtellous, up to 1 5 cm. long, the bracts round-peltate, about 0.5 mm. wide, the ovary obovoid, apex oblique, stigma single, subapical, the filaments about equaling the ellipsoidal anthers, the fruit about 0.8 mm. long, globose, stigma slightly subapical, verrucose, viscid, eventually on pseudopedicels

Caroline Islands: Truk Islands, Suiyoto (Tol I.), on shaded ground or rock, January 3, 1936, *M. Takamatsu 21* (type, Bishop Mus.).

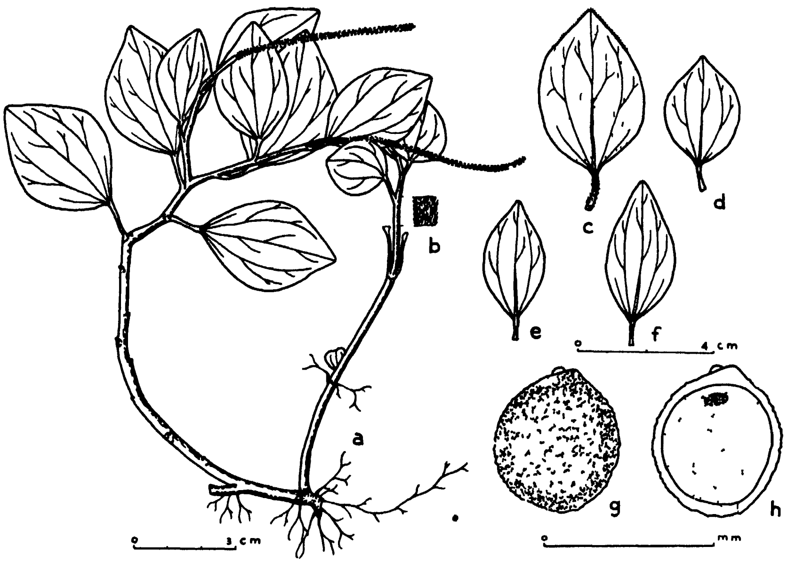

FIGURE 9.—*Peperomia trukensis* Yuncker: *a,* plant; *b,* section of stem, enlarged; *c-f,* leaves, showing variation in size and shape; *g,* fruit; *h,* section of fruit.

The hairiness of the plants and the large, oval leaves distinguish this from the other Micronesian species. It bears some resemblance to *P. samoensis* Warburg but differs from that species in its alternate leaves, shorter hairs, etc. The name is taken from the islands where the type was collected.

12. Peperomia kusaiensis Hosokawa.

Peperomia kusaiensis Hosokawa, Nat. Hist. Soc. Formosa, Trans., **25:** 120, 1935.

Plants hirsute or hirtellous, ascending from a decumbent and rooting base. Leaves alternate, 1.5 × 2.5 cm., margins densely ciliated, spikes about equaling the blades. This species appears from the description to differ sufficiently from the other species here included.

Caroline Islands: Kusaie, in a *Eugenia-Astronia* forest at upper altitudes of Mount Buache, July 29, 1933, *T. Hosokawa 6278* (type not seen, Taihoku Imp. Univ.).

13. **Peperomia pacifica** Hosokawa.

Peperomia pacifica Hosokawa, Nat. Hist. Soc. Formosa, Trans., **25**: 119, 1935.

This is an erect, hirsute or hirtellous species with alternate or rarely opposite leaves, 2 × 3 cm., and spikes shorter than the leaves. In these characters it differs from the other species which have been studied.

Marianas Islands: Saipan, in a secondary forest at middle altitudes, July 17, 1933, *T. Hosokawa 6654* (type not seen, Taihoku Imp. Univ.).

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV April 4, 1938 Number 3

A New Species of Phyllostegia and Two New Varieties of Cyanea of the Hawaiian Islands

By E. Y. HOSAKA and OTTO DEGENER

Phyllostegia Yamaguchii Hosaka and Degener, new species (fig. 1).

Planta suffruticosa ramosa 1-2 metra alta pilosa, truncus quadrangularis, foliis 7-12 cm. longis 3.5-5 cm. latis, acuminatis ovatis oblongis subcordatis ad cuneatis ad basim pilosis; pedunculus 1-4 mm. longus, tubo calycis 3-4 mm. longo labis calycis 1-1.8 mm. longis pilosis; corolla tuba 10-12 mm. longa alba pilosa.

Plant branching, suffruticose, 1-2 m. high, with horizontal branches, pilose throughout, stem quadrangular, hollow, dark purplish to dark reddish; leaves on petioles of 3.5-4.5 cm. long, purplish, pilose, blades 7-12 cm. long, 3.5-5 cm. wide, ovate-acuminate to oblong-acuminate, subcordate to cuneate at base, margin serrate, chartaceous, sparsely pilose on both surfaces, dark green above, whitish beneath, veins not prominent; inflorescence terminal to subterminal, 15-30 cm. long, branching, leafy at base, upper ones bracteiform, ovate-acuminate, 8-15 mm. long, 4-8 mm. wide, serrate, sparsely pilose, petiolate to subsessile; flowers 3 in each axil, raised on a common peduncle, 1-4 mm. long, purplish, pilose; pedicels 6-8 mm. long, slender, subtended by short filiform bractlets; calyx tube 3-4 mm. long, 2-3 mm. wide, with short, triangular, acute, obconical, purplish, pilose lobes, 1-1.8 mm. long; corolla white, with purplish tinge on the upper and the lower lips, tube 10-12 mm. long, 2.5-3 mm. wide, slightly wider at the throat, upper lip 3-4 mm. long, rounded at the tip, lower lip 9-12 mm. long, rounded at the tip, cleft above the middle into small blunt lobes, pilose on the outer surface, pubescent within; stamens slightly protruding beyond the tube; stigma bilobed, only the lower one capitate at tip; fruits 5-7.5 mm. in diameter, obovate, 4-parted, black when ripe, glabrous; nucules 4-5 mm. long, triangular in cross section, obovate, subtruncate at apex.

Oahu, Koolau Range, Laie, Puu Kainapuaa, very rare in open, wet summit ridge, altitude 2,500 feet, December 19, 1937, *E. Y. Hosaka* and *M. Yamaguchi 1924* (type in Bishop Museum).

This new species is closely related to *Phyllostegia glabra* (Gaud.) Benth. and especially to its variety *Macraei* (Benth.) Sherff. It can

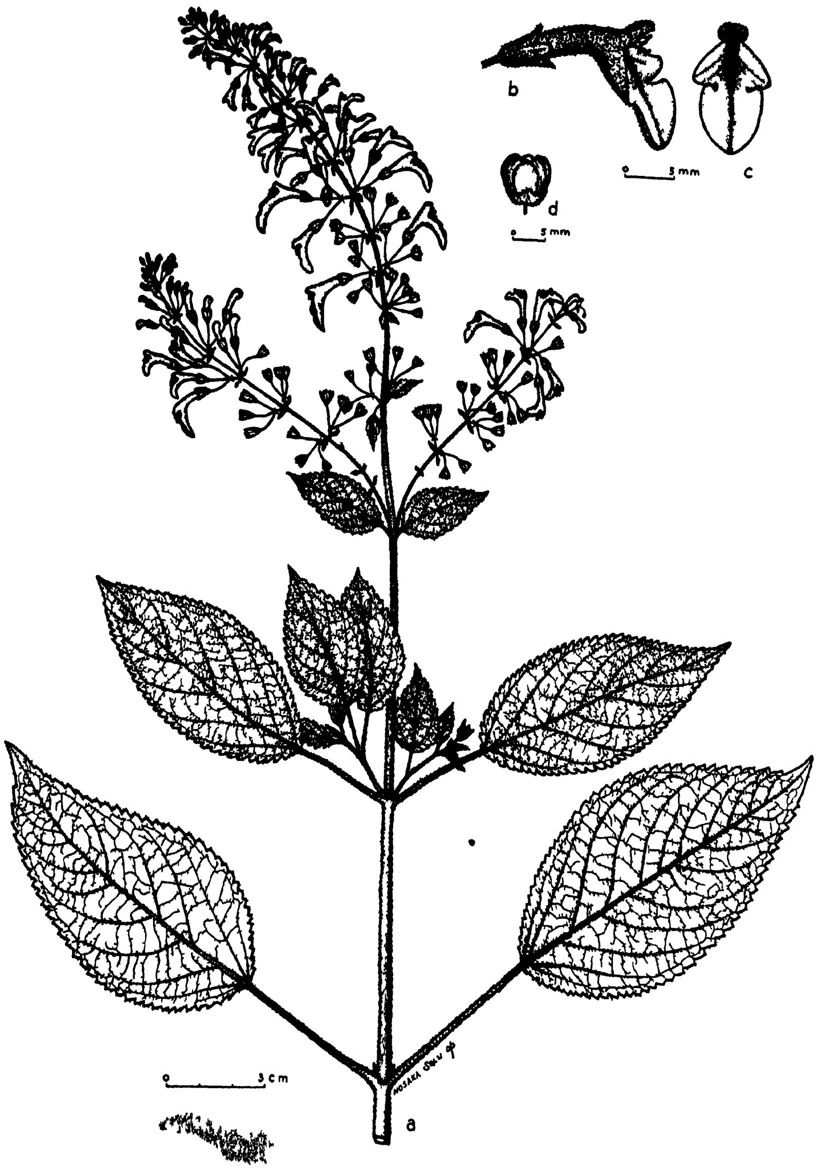

FIGURE 1—*Phyllostegia Yamaguchii* *a*, flowering branch, *b*, flower, side view, *c*, flower, front view, *d*, fruit

be distinguished easily from the species and variety by the following characters: *Phyllostegia Yamaguchii* is pilose throughout, with square stem; peduncles 1-4 mm. long; calyx tube 3-4 mm. long, lobes 1-1.8 mm. long, pilose; corolla tube 10-12 mm. long, pilose. *Phyllostegia glabra,* on the other hand, is glabrous throughout, with rather terete stem; peduncles 4-8 mm. long; calyx tube 6-8 mm. long, lobes 2-3 mm. long, glabrous; corolla tube 14-22 mm. long, glabrous. The variety *Macraei* differs from *P. Yamaguchii* in being glabrous throughout, with square stem; peduncles 4-8 mm. long, calyx tube 4-4.5 mm. long, lobes 2-2.5 mm. long, glabrous; corolla tube 8-12 mm. long, glabrous.

This species is named for Mr. Michio Yamaguchi, teacher of agriculture at Waipahu, Oahu, and amateur botanist, who has collected many plants in the Hawaiian mountains with the authors.

Cyanea acuminata (Gaud.) Hillebr. variety **calycina** Hosaka, new variety (fig. 2).

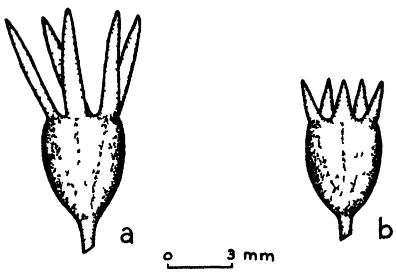

FIGURE 2.—*a, Cyanea acuminata* variety *calycina,* calyx; *b, Cyanea acuminata,* calyx.

Planta stricta 1-1 5 metra alta, labis calycis 4-5 mm. longis, corolla subpuberula, columna staminea glabra.

Plant erect with simple stem, 1-1.5 m. tall, leaves broad-oblong, acuminate at both ends, glabrous above, sparsely puberulous below; peduncles sparsely puberulous; calyx lobes 4-5 mm. long, lance-acuminate; corolla faintly puberulous; staminal column glabrous.

Oahu, Koolau Range, Waipio, Kipapa Gulch, altitude 1,700 feet along stream bed, August 7, 1933, *E. Y. Hosaka 1185* (type in Bishop Museum).

This variety closely resembles *Cyanea acuminata* (Gaud.) Hillebr. but differs in having glabrous upper leaf surface, calyx lobes 4-5 mm.

long, corolla faintly puberulous, staminal column glabrous. *Cyanea acuminata* has puberulous upper surface of leaf, calyx lobes 2 mm. long, corolla conspicuously puberulous, staminal column puberulous.

Cyanea Grimesiana Gaud. variety **Munroi** Hosaka, new variety.

Labis calycis 10-13 mm. longis.

Plant simple to branching, 1-3 m. tall; leaves 30-65 cm. long, 15-25 cm. wide, laciniate; calyx tube 7-10 mm. long, cylindrical, glabrous, lobes 10-13 mm. long, 4-6 mm. wide, broadly lanceolate; corolla (measured along curve) 4.5-5.5 cm. long, about 5 mm. wide, curved, glabrous; anther hirsute at base.

Lanai: Mts. E. end, June 1913, *C. N. Forbes 266L.*; August 23, 1919, *G. C. Munro 673*; Mahana, August 23, 1919, *G. C. Munro 276*; Ravine in Mt., moist woods, September 22, 1916, *A. S. Hitchcock 14703*; Kaiholena, November 3, 1913, *G. C. Munro 166* (type in Bishop Museum).

This new variety closely resembles *Cyanea Grimesiana* Gaud. variety *mauiensis* Rock, but differs from it in having calyx lobes 10-13 mm. long, whereas variety *mauiensis* has calyx lobes 24-36 mm. long.

Rock [B. P. Bishop Mus., Mem. 7 (2) : 251, 1919] cites Hitchcock's specimen no. 14703 under variety *mauiensis* and says that this variety had not been reported previously from Lanai. Hitchcock's specimen is distinctly different from the type of variety *mauiensis* and is similar to the new variety *Munroi,* known only from the island of Lanai.

This variety is named for Mr. George C. Munro who has made the largest collection of Lanai plants during his long residence on the island.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV April 12, 1938 Number 4

Ericaceae and Santalaceae of Southeastern Polynesia[1]

By CARL SKOTTSBERG

BOTANICAL GARDENS, GÖTEBORG, SWEDEN

INTRODUCTION

Of the Ericaceae, the Mangarevan Expedition in 1934 collected a single species, *Vaccinium rapae* Skottsberg, endemic to Rapa and now collected for the third time, having been known previously from the type material, Collenette 782 (8, p. 97)[2], and specimens collected by Mrs. A. M. Stokes (2, p. 217).

Of the sandalwoods, three different forms of the *Santalum insulare* assemblage have been known previously from Mrs. Stokes' collection. They were described at length by Brown (2). His description leaves no doubt that we deal here with exactly the same forms, but the new material is more ample and permits us to get a better idea of the validity of certain characters used to distinguish *S. marchionense* from *S. insulare* (7).

Of *Exocarpus*, a new species was discovered in Rapa. The genus is new to southeastern Polynesia.

Genus VACCINIUM Linnaeus

Vaccinium rapae Skottsberg, Meddel. Göteborgs Bot. Trägård 8:96, 1933.

Rapa: 1 km. northwest of Narioa Point, alt. 3 m., grassy slope, low shrub 0.4 m. high, July 8, 1934, *St. John and Maireau 15445*

[1] Mangarevan Expedition Publication 21.

[2] Numbers in parentheses refer to Literature Cited, p. 43.

(in fruit); Tuko, open, damp, boglike slope, alt. 40 m., low bush 0.5 m. high, flower greenish white, fruit dark red to purple, quite edible, good flavor, July 9, 1934, *Fosberg 11478*; Tubuai Bay, grassy hillsides, alt. 75 m., bush 0.3 m. high, flower white, fruit glaucous, blue, July 19, 1934, *St. John and Maireau 15457*; Mount Taga above watering place, boggy, turfy slope, alt. 75-200 m., shrub almost prostrate, flower light green, corolla 7 mm. wide at widest point, 4 mm. at narrowest point, 10 mm. long, fruit spherical, maroon, mostly immature, July 4, 1934, *Fosberg 11392*; Kaimaru, south ridge of Mount Perahu, alt. 500 m., thicket on steep ridge, decumbent shrub, height 0.2 m., July 13, 1934, *St. John and Maireau 15514* (sterile); hillside, July 1, 1934, *D. Anderson* (with fruit).

A low, compact, often decumbent shrub, the young branches minutely pubescent, otherwise glabrous, densely foliose. Leaves short petiolate (1-2 mm.), coriaceous, ovate-elliptic-obovate to suborbicular and broadly truncate, 20-40 mm. long, 14-34 mm. wide, with incrassate and more or less distinctly serrate edge, glabrous except along midrib, with a net of incrassate veins on both faces, discolorous, grayish green above, brownish green below when dry. Flowers solitary and axillary on a naked peduncle of 5-10 mm., subglabrous; calyx glaucescent, lobes narrow triangular, obtusate, (3-)4-6 mm. long and (1.5-)2-2.5 mm. wide; corolla urceolate, greenish white, 8 10 mm. long, 4-5 mm. wide, tips 2-3 mm. long and 1.5-2 mm. wide, their inside densely pubescent; stamens 4-5 mm. long with filament 2.5-3 mm. and anther 2.5-3.5 mm, bristles 1.2 mm.; style 6 mm. long. Berry globose, about 7 mm. in diameter; seeds ferrugineous, with reticulate testa, 1-1.2 mm long.

The leaves vary as to shape and serrature; in no. 11478 some leaves are almost entire; in no. 15514 all are sharply serrate. In no. 11392, many hexamerous flowers are observed.

V. rapae shows the same mode of development of the vegetative-floral shoots as the Hawaiian Macropelmas; the innovation begins with a few reduced leaves, more or less like bud-scales, followed by normal, but comparatively small leaves. Both scales and leaves may support flowers.

Genus SANTALUM Linnaeus

Santalum insulare Bertero.

Typical *S. insulare* is known from Tahiti and Raiatea (9). The Marquesan sandalwood, formerly referred to the same species, was distinguished by me as *S. marchionense* (7, p. 142). I found that the leaves were almost alike in both, perhaps on an average more ovate to ovate-lanceolate in the latter, and more truly oval or elliptic to

elliptic-lanceolate in the former [Brown's key (2, p. 61) simplifies matters a little too much according to my view], and that the receptacle was deeper in *S. insulare* with a longer free beak of the ovary and a longer style. The discovery of closely related forms in Raivavae and Rapa, which according to Brown (2) are intermediate between the two, made me reexamine *S. marchionense.* In a fully expanded flower, the style (including free portion of ovary) attains a length of 1.8-2 mm. (1.25-1.8 according to Brown), and the stamens, which as a rule are larger in *S. insulare* (1.5 mm., anther 1.2 mm.), may occasionally reach the same length in *S. marchionense,* and, though as a rule the anthers are smaller in *S. marchionense* (not over 1 mm.), a size of 1.1 mm. has been measured. It therefore seems impossible to retain *S. marchionense* as a species, and henceforth I shall call it *S. insulare* var. *marchionense.*

Santalum insulare var. **raivavense** F. B. H. Brown, B. P. Bishop Mus., Bull. **130**: 62, 1935; (fig. 1, *a-f*).

Austral Islands: Raivavae, Vaiannaua Peninsula, west side, alt. 60 m., brush at top of forest, small tree 4 m. high, diam. 10 cm., Aug. 6, 1934, *Fosberg 11683* (small buds only); same locality and date, tree 5 m. high, flower greenish turning reddish, strong sweet odor, *Fosberg 11687*; east side, steep brushy slope, top of forest, alt. 30 m., erect shrub 2 m. high, flower white, turning red, very sweet odor, leaves pale green, Aug. 6, 1934, *Fosberg 11686* (buds and mature flowers); north slope of Mount Hiro, thicket on ridge, alt. 50 m., small tree 5 m. high, Aug. 10, 1934, *St. John 16077* (buds); Motu Tehau, coral gravel, alt. 1 m., tree 4 m. high, Aug. 11, 1934, *St. John and Wight 16139* (young buds only); Hotuatua Islet, dry, rocky hillside, alt. 2 m., shrub 2 m. high, leaves pale green beneath, Aug. 11, 1934, *St. John and Wight 16114* (sterile).

The type is Stokes 100 from Raivavae, Taniora, at 900 meters altitude (2). It is said to differ from *S. insulare* of Tahiti "in the more numerous veins of the leaves, shorter pedicels, shorter stamens, and shorter style." A description based on the very ample material now at hand follows:

Leaves coriaceous; petiole 6-17 mm. long, generally 8-13 mm.; blade ovate to ovate-elliptic to ovate-lanceolate or broad elliptic to oval, 5.5-10 cm. long, 3-6 cm. wide, pointed (not very sharply as a rule) to obtuse with about 6-10 (rarely more) lateral veins on either side. Inflorescence small, 4-6 cm. long, few-flowered. Flowers 5 mm. long, including the very short (less than 1 mm.) pedicel; tube 2 mm. or slightly longer; perianth lobes 2.4-2.5 mm. long and

1.9-2 mm. wide; disc lobes 0.7-1 × 0.8-1.1 mm., orbicular-quadrate; stamens 1.3-1.4 mm. with anther of 0.9-1.1 × 0.9-1.1 mm.; style including free portion of ovary 1.7-2 mm., solid style with stigma 0.8-1 mm.; stigmas nearly always 3, rarely 4.

The Raivavae sandalwood is closer to var. *marchionense* than to typical *S. insulare.* The leaf shape covers the whole range found in the forms of Tahiti and the Marquesas; the number of veins is no greater than in these: commonly 7-8 in nos. 11683, 11686, 11687, and 16139; perhaps oftener 8 or 9 in no. 16077 where the leaves are somewhat larger; and as many as 10 or 12 in no. 16114 in which the leaves are largest (sterile shoots) (fig. 1, *a-d*). There are quite as many lateral veins in *S. insulare* from Raiatea. The stamens agree closely with those in var. *marchionense,* and the style is almost the same length. The only characters which distinguish var. *raivavense* from var. *marchionense* are the subsessile flowers and the commonly trimerous gynoecium.

Santalum insulare var. **Margaretae,** new combination (F. B. H. Brown, B. P. Bishop Mus., Bull. **130**: 62, fig. 12, *a-k,* 1935); (fig. 1, *g-k*).

Rapa: about six trees on open slopes in saddle west of Mount Tanga, alt. 250 m. Tree 5 m. high, diam. 10 cm.; flower: sepals without green, within at first greenish white, later deep rose-magenta, disc lobes fleshy, yellowish, stamens brown, fimbriate scales white, flowers with strong, sweet perfume, July 23, 1934, *St. John and Anderson 15692.*

This was described (2, p. 62) as *S. Margaretae* and said to be very close to *S. marchionense* and *S. insulare,* the length of the style and depth of the receptacle being intermediate between the two, whereas the leaves agree with those of *S. insulare* in shape but are smaller and relatively narrow. The type is Stokes 392 (2, p. 63, fig. 12). The following description is based on the numerous specimens now at hand:

Leaves soft coriaceous; petiole short (5-)7(-9) mm.; blade elliptic to oblong, obtuse, 6-8 cm. long, 2.5-3.5 cm. wide, with about 7 lateral veins on either side of midrib. Panicle 3-6 cm. long, few-flowered. Flowers 5 or occasionally as much as 6 mm. long, nearly sessile; tube 2-2.5 mm., tepals 2.5 (-3) mm. long and 1.8-2 mm. wide; disc lobes rotundate-quadrangular, 0.8-0.9 × 1 mm.; stamens 1.3-1.5 mm. long, anther 1-1.1 × 1 mm.; style including free portion of ovary 1.8-2 mm., solid style with stigma about 1.2 mm.; stigmas as a rule 3, rarely 4. Drupe 12 × 10 mm. according to Brown (2).

Brown indicates 2.3-2.4 mm. as length of style, as in *S. insulare typicum,* but of the several flowers I have examined none had a style longer than 2 mm., some only 1.8-1.9 mm. So that 2.4 would seem exceptional. In flower structure, *S. Margaretae* agrees closely with var. *marchionense,* but differs from it as well as from *S. insulare typicum* in its subsessile flowers, short petioles, and narrower blades; but it must not be forgotten that all the material belongs to a single collection and the type very likely came from the same group of trees.

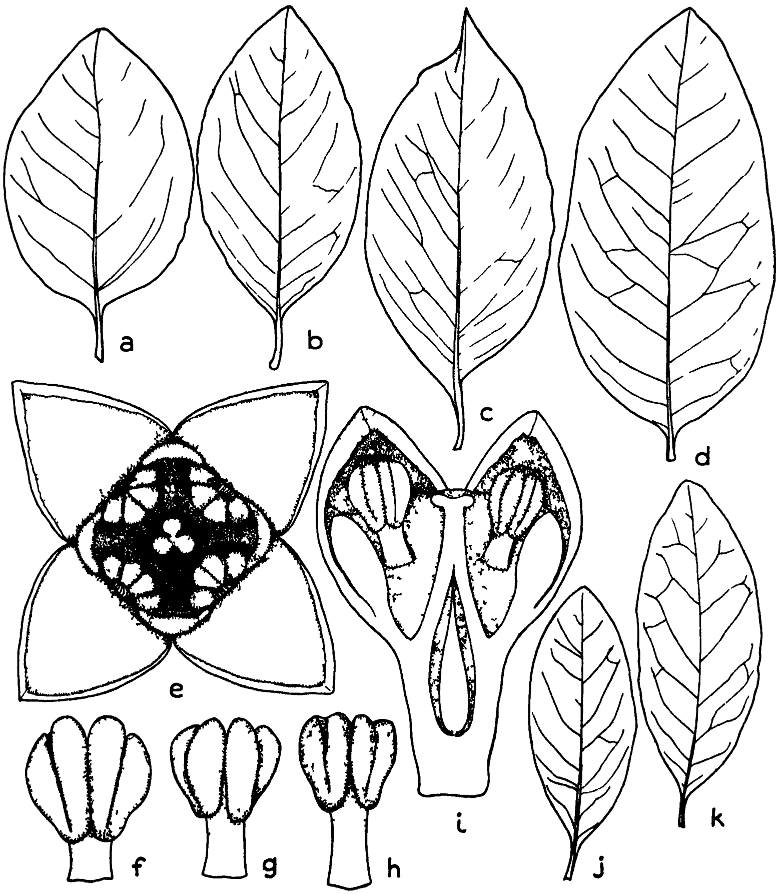

FIGURE 1.—*Santalum insulare* (*a-f*, var. *raivavense, g-k,* var. *Margaretae*): *a-d,* leaves, ½ nat. size: *a,* no. 11683; *b,* no. 11686; *c,* no. 16139; *d,* no. 16114; *e,* flower, no. 11686, × 10; *f-h,* stamens, × 15: *f,* no. 16077; *i,* flower in section, × 10; *j-k,* leaves, ½ nat. size (*g-k,* no. 15692).

As leaf width rarely surpasses 3 cm., *S. Margaretae* is a well marked form, but as I am unable to discover any characters of specific value in the flower structure, I find it necessary to reduce it to a variety of *S. insulare* in the wider sense used here.

Santalum hendersonense F. B. H. Brown, B. P. Bishop Mus., Bull. **130**: 66, fig. 12, *l-s*, 1935; (figs. 2-3).

Henderson Island, north end, thicket top of coral cliff, alt. 25 m., erect, 1 m. high, flowers green, stamens brown, odor heavy, sweet,

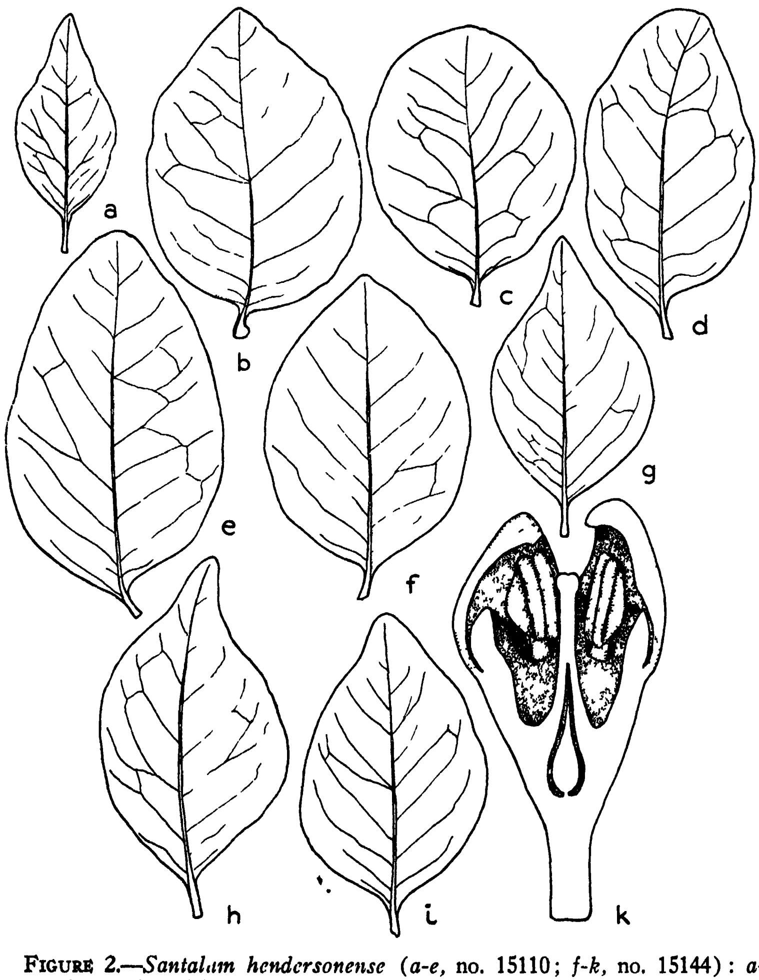

FIGURE 2.—*Santalum hendersonense* (*a-e*, no. 15110; *f-k*, no. 15144): *a-e*, leaves, ½ nat. size; *f-i*, leaves, ½ nat. size; *k*, flower in section, × 10.

June 17, 1934, *St. John and Fosberg 15078*; jungle on elevated dissected coral, alt. 30 m., tree 4 m. high, diam. 15 cm., flower petals orange-brown, stamens dark brown, heavy, too sweet odor, bark brown, sapwood white, heartwood brown, June 17, 1934, *St. John and Fosberg 15110*; same locality and date, alt. 33 m., tree 3 m. high, diam. 7 cm., flower light green, heavy sweet fragrance—unpleasant, *St. John and Fosberg 15079*; same locality and date, tree 8 m. high, diam. 20 cm., flowers sweet, too heavy perfume, tube greenish, tepals orange-brown, scales white, anthers dark brown, leaves chartaceous, impressed rugose above, glaucous beneath, fruit green, *St. John and Fosberg 15144*.

According to Brown (2), this belongs to section Hawaiiensia[3] Skottsberg (6) whereas all the other sandalwoods of southeastern Polynesia belong to section Polynesica[4] Skottsberg (6); Brown figures a longitudinal section of a flower with an inferior ovary (2, fig. 12, *l*). As his description shows that, in all other respects, the new species comes very near broad-leaved forms of *S. insulare* (in a broad sense), the structure of the ovary was unexpected. The type is not indicated, but presumably it is a specimen collected by Mrs. Stokes.

The present material is quite ample and should cover the whole range of variation which is considerable as regards leaf shape, whereas the flowers are very much alike in all specimens. I was able to examine a good number representing all the lots, but I have been unable to discover a single flower with an inferior ovary; every one has a semi-superior ovary of precisely the same kind as that in *S. insulare* and others (figs. 2, *k*; 3, *d, e*). Consequently it would seem logical to reduce *S. hendersonense* also to a variety of *S. insulare*. My description below explains why this is not done.

A tree to 8 m. high; leaves with a petiole of (4-)5-7(-8) mm., blade suborbicular in no. 15110, oval or elliptic in no. 15078, and ovate or ovate-elliptic and often distinctly acuminate in no. 15114, in all more or less pronouncedly obtuse, 5-9 cm. long, 3.2-5.7 cm. wide. Figures 2, *a-i*, and 3, *a-c*, illustrate the various forms; it must be remembered that the shape differs greatly in leaves from the same branch. Panicles 4-6 cm. long, usually 3 together at the end of the branches (1 terminal, 2 axillary), in some plants additional ones from lower axils. Flowers distinctly pedicellate, 6-7.2 mm. long including pedicel; ovary semi-superior; tepals 2 5-3 × 1.9-2.2 mm.; disc lobes rounded-quad-

[3] Not "Hawaiiensis", as written by Brown.

[4] Not "Polynesia", as written by Brown.

rangular, about 1 mm each way, stamens 1 4-1 5 mm, attaining 1 8 mm in no 15079, anthers 1-1 25 × 0 9-1 mm, style including free tip of ovary 1 7-2 5 mm (commonly 2), solid style with stigma 1 2-1 5 mm Stigmas 3, very rarely 4 Drupe (only one seen) large, 23 mm long and 17 mm wide in a dry state, on a thickened pedicel of 7 mm

I think it best to recognize *S hendersonense* as a species by itself The leaves show a tendency to become acuminate, they are as wide in relation to their length as those in *S insulare* var *marchionense*

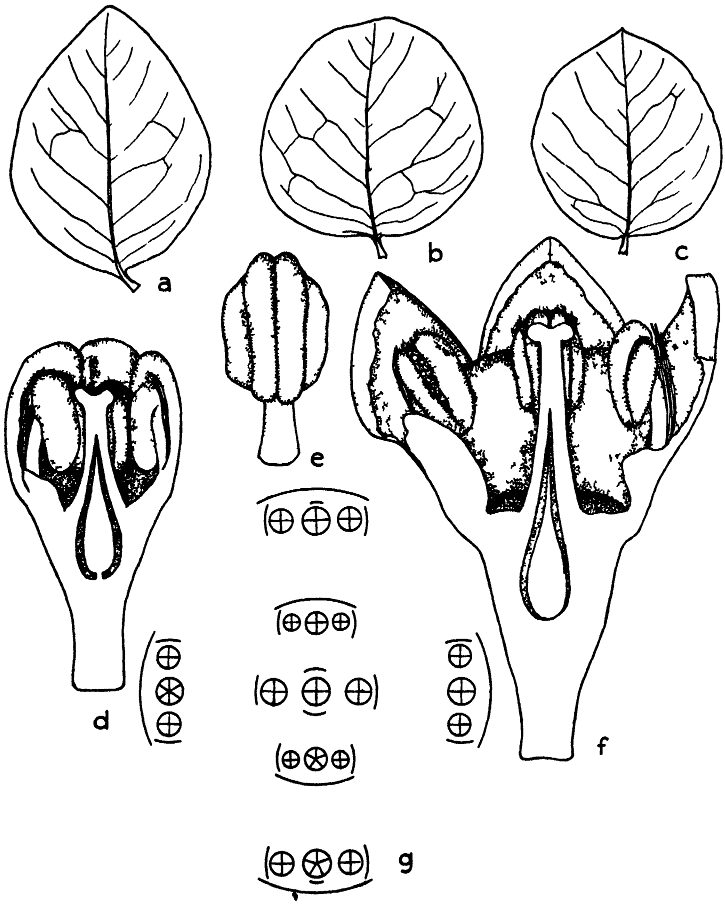

FIGURE 3—*Santalum hendersonense* (*a-f*, no 15079, *g*, no 15110) *a-c* leaves, ½ nat size, *d*, bud, and *f*, open flower in section, × 10, *e*, stamen, × 15, *g*, diagram of top of panicle, showing, besides the tetramerous flowers, 2 pentamerous and 1 hexamerous

and var. *raivavense,* but shorter petiolate. The flowers are more numerous, the number of branches to the panicle being greater. Pentamerous flowers are often observed. In no. 15079, they are quite common; of 12 flowers dropped from the branches, 5 were tetramerous in tepals and stamens, 2 of these also in the gynoeceum, the other 3 having 3 stigmas, 6 were pentamerous (1 had only 4 stamens, all had 3 stigmas) and 1 hexamerous (5 stamens, 3 stigmas). Pentamerous flowers occur in all the other specimens, but are more scarce (3 of 16 examined in no. 15110, 2 of 4 in no. 15018, and 1 of 10 in no. 15114). This tendency is interesting. Further, the great size of the drupe is remarkable. Unfortunately we know little about the fruit in this group, but *S. hendersonense* must, for the present, be regarded as a separate species, even though it is more similar to the rest than was assumed by Brown.

No. 15110 offered a good opportunity to study the morphology of the panicle. A diagram of a regular panicle top is shown in figure 3, *g*. The position of the perianth in relation to the bracts is the same in all specimens and equal in terminal and lateral flowers.

Genus EXOCARPUS Labillardière

Exocarpus psilotiformis Skottsberg, new species (figs. 4, 5).

Autexocarpus, Euexocarpus. Frutex (vel arbor?) erectus rigidus scoparius, subaphyllus, glaber, ad 3 m. altus. Rami erecti scopas densas formantes, vetustiores fusci, subteretes-trigoni, lineis elevatis pallidis notati, 3-4-5 mm. crassi, aphylli, juniores virides, complanato-trigoni, 1.5-2 mm. lati, conspicue vittati et sulcati, ultimi 0.5-1 mm. lati, primum foliosi; internodia plerumque 0.5-2 cm. longa, versus basin sensim angustata. Folia alterna, ad angulos innovationum sessilia, carnosula, lineari-filiformia, obtusiuscula, 2.5-3.5 mm. longa et 0.5 mm. lata, caducissima, basi conica minuta dentiformi persistente. Flores in spicas axillares brevissimas, 2-3 mm. longas subsessiles paucifloras dispositi, rhachide paulum immersi, monoici, pentameri. Bracteae cucullato-triangulares, minutae, acutae. Flos ♂ expansus circ. 2 mm. diam. Tepala triangularia, 0.8 mm. longa et 0.6 mm. lata, receptaculo patelliformi subplano; stamina erecta, 0.5-0.6 mm. longa, anthera latior quam longa, 0.25-0.3 × 0.4-0.45 mm., filamento latiusculo; discus obtuse pentagono-lobatus, 0.7-0.8 mm. diam.; pistillodium minutum conicum. Flos ♀ expansus usque 3 mm. diam., receptaculo depresse conico, dein elongato; tepala ut in ♂ sed paulo majora, 1 × 0.7 mm.; staminodia 0.4 mm. longa, anthera 0.2 × 0.25 mm., in discum 0.8-1 mm. latum incumbentia; pistillum conicum 0.7 mm. altum stigmate truncato subintegro sessili. In statu fructifero receptaculum valde incrassatum, carnosum, rubrum, tepalis coronatum, 8-8.5 mm. (vel ultra?) longum, apice sec. cl. Fosberg 8-9 mm., inferne 6 mm. crassum; drupa sicca, ovoidea, acutiuscula, 8 mm. longa et 4 mm. lata, quarta (tertia?) parte receptaculo immersa.—Affinis *E. stricto*;

differt ramis paulo latioribus, receptaculo multum magis incrassato nec non drupa majore, magis elongata.

Hab. in ins. Rapa ubi legit *F. R. Fosberg n. 11561.* Typus in herb. Honol.

A broomlike, rigid, glabrous shrub, "strictly erect, height 3 m.," extremely like *Psilotum nudum* if we do not consider the difference in size. *Psilotum* is occasionally found in herbaria under *Exocarpus.* Lower parts of oldest branches

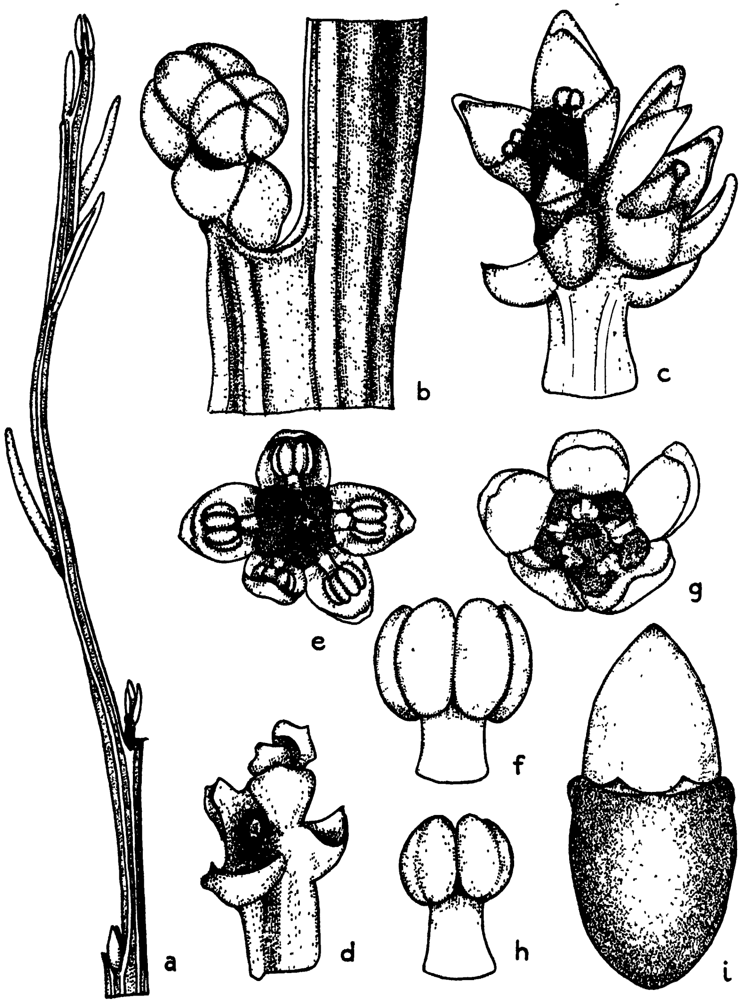

FIGURE 4.—*Exocarpus psilotiformis: a,* top of branch showing leaves, × 5; *b,* node with spike (male flowers in bud), × 15; *c,* spike with 2 female flowers, × 15; *d,* rhachis of same, showing cup with scar left of flower, × 15; *e,* male flower, × 15, and *f,* stamen, × 50; *g,* female flower, × 15, and *h,* staminode, × 50; *i,* drupe with receptacle, × 3.

seen subterete, brown with elevated lines of a lighter color; largest diameter observed, 5 mm.; the following branches presumably brownish green, cylindric-trigonous, the angles marked by a narrow ridge, the sides conspicuously vittate-sulcate; younger branches green, complanate-trigonous, marked with the same prominent lines with furrows between; internodes as a rule from 5 to 20 mm. long, 1.5-2 mm. wide at top, less than 1 mm. at base; youngest, still leaf-bearing branches 0.5-1 mm. wide. The branching is sympodial; when a branch stops growing it is overtaken by a side branch below the tip. Branches issue at a very acute angle, so that the whole system forms a dense, narrow broom. Leaves alternate, linear-filiform, ± obtuse, slightly fleshy, 2.5-3.5 mm. long, and 0.5 mm. wide; they are found only in the top region, being exceedingly caducous, but the hardened base persists as a small, conical knob. Flowers in subsessile, 2-3 mm. long, few (3-4)-flowered spikes, monoecious, pentamerous, supported by a minute, cucullate, toothlike bract but without bracteoles. Male flower about 2 mm. across when expanded, with flat, little developed receptacle; tepals triangular, 0.8 mm. long and 0.6 mm. broad at base, stamens erect, 0.5-0.6 mm. long with short and broad filament, the four-celled anther 0.25 + mm. long and 0.4 + mm. wide; pollen grains ellipsoid, smooth, 18-21 × 12-15 μ; disc flat, slightly 5-lobate; pistillode minute, conical. Female flower slightly larger, almost 3 mm across, with a more developed receptacle; tepals 1 mm. long and 0.7 mm. wide; staminodes conspicuous, bent over the disc, 0.4 mm. long with a sterile anther of 0.2 × 0.25 mm.; ovary sunk with its base in the receptacle, its free part with the sessile, truncate stigma 0 7 mm. long. As in several other species the receptacle becomes much enlarged, swollen and quite showy in fruit ("fruit fleshy, receptacle red, fruit green, receptacle 8 to 9 mm. wide at top, 6 mm. wide at base, fruit sunken 1/3 of length") ; it attains a length of at least 8 mm. (the original size is not quite regained even after prolonged immersion in boiling water). Drupe surrounded at base by the receptacle and by the persistent tepals, ovoid, pointed, about 8 mm. long and 4 mm. across, with a thin, leathery exocarp.

Rapa, Kaukauamoo, very steep side of top of ridge, alt. 350 m., fl.-fr., July 18, 1934, *Fosberg 11561.*

There are very few spikes left, so that little material was available for a detailed study. Of the two spikes examined, one had 2 flowers left, both ♀ ; 2 had been lost. At the top were 3 sterile bracts. The other spike bore 2 flowers, both ♂ , a third had fallen off. It is possible, but not at all certain, that the spikes are unisexual. To judge from the material at hand, only one fruit is developed in a spike. The same is apparently true in *E. strictus.*

The new species belongs to subgenus *Autexocarpus* Pilger (4, p. 121; 5, p. 69), sect. *Euexocarpus* A. DC., and to a group with sessile, few-flowered spikes comprising a number of Australian and Tasmanian species; *E. Bidwillii* Hook. f. from New Zealand also belongs here. The Hawaiian species belong to the same section, but form their own little group, characterized by its heterophylly. *E. psilotiformis* is nearly related to *E. strictus* R. Br. of Australia and Tas-

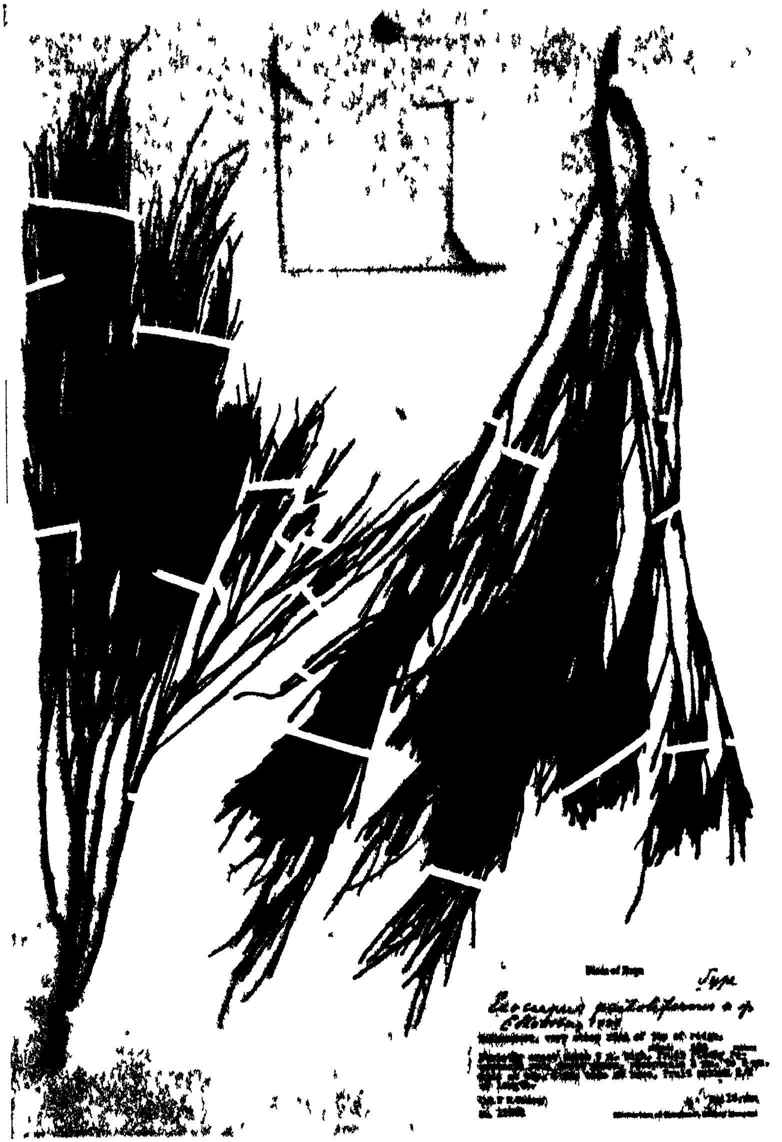

FIGURE 5.—*Exocarpus psilotiformis*, type specimen, × 1/3

mania, but differs from this in its coarser and more rigid habit, its slightly wider joints, the much more incrassate receptacle and the larger, more pointed drupe. In the specimens of *E. strictus* examined by me (from Tasmania), the flattened joints rarely exceed 1 mm. in width, the receptacle is cylindric-obconical, 3.5 ± mm. long, only 2 ± mm. wide at top, the drupe nearly globular, 3.5 ± mm. long and 3 ± mm. wide.

According to Pilger (5, p. 75), *Omphacomeria psilotoides* A. DC. (3, p. 681) is identical with *Exocarpus strictus*. It seems appropriate to commemorate the psilotoid habit of certain of the Exocarpi; hence the name *psilotiformis,* given to the new species, which of all species is most like the fern genus *Psilotum*. They offer an interesting example of morphological convergence.

From a geographical point of view, the discovery of *E. psilotiformis* is of considerable interest as it fills out the gap between Tasmania and the Hawaiian islands.

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OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV May 31, 1938 Number 5

Ferns of Southeastern Polynesia[1]

By E. B. COPELAND

INTRODUCTION

The material submitted for study consists of 629 collections, of which 2 are from Flint Island, 157 from the Society Islands, and 470 from the islands to the south and southeast of the Society Islands.

The ferns of the Society Islands were treated comprehensively in Bulletin 93 of Bernice P. Bishop Museum. Bulletin 102 by J. W. Moore added 12 species. The present collection adds:

Dryopteris Haenkeana (Presl) O. Kuntze
Polystichum paleatum, new species
Lindsaya eximia, new species

Moore's work and these additions increase the apparent endemism of this group from 30 percent to 35 percent. The fern flora of these islands needs no further discussion at this time.

Neither is any considerable discussion of the flora of southeastern Polynesia required. The general condition has already been depicted by Dr. and Mrs. F. B. H. Brown in Bulletin 89. The more ample collections now in hand from the Austral Islands, Rapa, Mangareva, and Pitcairn do not change their conclusions except in detail; and a general discussion of the Polynesian fern population should await a comprehensive collection of Polynesian fern flora. For an understanding of this flora as a whole, it is the islands to the far west which have still to provide the most needed information. The New Hebrides and New Caledonia are regarded as fairly well explored. The Solomon Islands are not so, and the considerable collection of their ferns which I have recently examined, made by Brass and Kajewski for the

[1] Mangarevan Expedition Publication 22.

Arnold Arboretum and Queensland Museum, demonstrates as a fact what was already almost sure: that they represent the path by which Malay-Papuan ferns reached Polynesia.

As a perfectly obvious preliminary statement, there are two original elements in the Polynesian fern flora, an Austral (Antarctic) and a Malay-Papuan. Leaving out of account the many rather local endemics when species are being considered, there has developed a small element of species widespread in Polynesia but peculiar to the region. This group of species is Austral rather than Malayan in general affinity. The Austral element of the flora is older here than the Malayan, and is probably being swamped by the latter.

We may picture the Austral immigration as coming by way of New Zealand (not, of course, from Australia, but from Antarctica), and the Malayan as coming by way of Papua. Both entered Polynesia far to the west of the region of this Expedition. In Polynesia, migration has been eastward, whatever its ultimate source. Step by step, eastward at least from Fiji, the evidence of direct connection with New Zealand grows progressively weaker.

The fern flora of southeastern Polynesia is now very well known. The fact that nearly all of the forty species accredited to Rapa in Bulletin 89 have been collected again by this Expedition is evidence that the collection is thorough. When I miss in this collection a fern supposed to have been described from Pitcairn, I suspect that the previous report was an error. Future exploration will reveal more novelties in Fiji and in the Society Islands than in the islands of the southeast.

As to endemism, the general conditions—its relation to area, age, altitude, and isolation—stand fairly independent of our attitude toward the concept of species. Bulletin 89 recognizes many varieties; I describe none, but with the same material we would draw approximately the same conclusions. With completeness of collection, the recognized proportion of endemics increases, because in general the endemics are the comparatively rare plants. With 56 species from Rapa instead of 40, I find 35 percent of endemism instead of 31 percent. A few years of more intensive collection have raised the recognized endemism in the Society Islands from 30 percent to 35 percent.

I continue to use *Sphenomeris* and *Campium* as generic names. Christensen, in the comprehensive Third Supplement to his Index,

posting Ching as responsible, rejects these in favor of *Stenoloma* and *Bolbitis*. In appreciation of the incalculable value of Dr. Christensen's Indices, it is the world's general practice to conform to his nomenclature. In publishing *Sphenomeris* and in reviving *Campium,* however, Dr. Maxon and I have presented good reasons for not adopting *Stenoloma* and *Bolbitis,* and I have not seen any refutation of these reasons by Ching or Christensen. If objection be made to *Campium* on the ground that it is imperfectly typified, the alternative name is *Cyrtogonium*. *Bolbitis* is an American genus derived from *Phlebodium* without a near relative in the Orient. When Ching restores *Colysis* as a genus, I can agree with him. When he and Christensen unite *Dendroglossa* with *Leptochilus*, I cannot agree, but the affinity is not very remote. But when they combine *Campium* (*Cyrtogonium* or *Heteroneurum*) with *Bolbitis,* it is no longer with me a matter of judgment, but one of fact. At this point, they are as completely and evidently wrong as when they persist in imputing a Dryopterid or Tectarid origin to any of these ferns.

This collection has been studied in and with the facilities of the herbarium of the University of California. The types of the new species are in the herbarium of the Bishop Museum; cotypes or type fragments are in the herbarium of the University of California. The collections are cited briefly under the collector's numbers. Numbers 11000 to 12172 were collected by F. R. Fosberg, and numbers 14106 to 17500 by H. St. John, either alone or assisted by Fosberg.

FILICINEAE

OPHIOGLOSSACEAE

Ophioglossum reticulatum Linnaeus.

Rapa, no. 15721; Mangareva, no. 14883.
Pantropic.

O. pendulum Linnaeus.

Tahiti, no. 17057; Raiatea, no. 17237; Tahaa, no. 17388; Meetia, no. 14180; Rurutu, no. 16651; Raivavae, no. 16057; Rimatara, no. 16787.
Westward to the Mascarenes.

MARATTIACEAE

Angiopteris evecta (Forster) Hoffman.

Huahine, no. 17203; Raiatea, nos. 17265, 17301; Raivavae, no. 15841; Rurutu, no. 11941.

Westward to Malaya.

A. longifolia Greville and Hooker.

Tahaa, no. 17355; Tubuai, no. 16445; Rapa, no. 15446.

A. longifolia Greville and Hooker was published as from "Pitcairn and Society Islands," which would make Pitcairn the type locality if the citation be accepted. DeVriese examined the material in Hooker's herbarium, collected "March to May, 1830," consisting of two specimens, "quae ad eamdem pertinent frondem"; and gave a very complete description with figures (Monographie des Marattiacées, p. 19, pl. III, IV, fig. 2, 1853). Recent Tahitian collections represent it perfectly, and specimens from Rapa and Rarotonga (the latter variable) conform satisfactorily. It is my belief that the species was described from Tahitian material only and that it does not occur on Pitcairn.

Angiopteris chauliodonta Copeland, new species (pl. 1).

Trunco testibus lectoribus 0.5 m alto stipitibusque carnosis; stipite sicco 2.5 cm crasso, plumbeo, glabrescente; fronde usque ad 4 m longa; pinnis medialibus 75 cm longis, rhachi superne plumbea vel nigra, inferne straminea sparse flocculosa; pinnulis brevi-pedicellatis, usque ad 18 cm longis, 2 cm latis, basi truncatis vel acroscopice rotundatis vel late cuneatis, margine denticulatis, costa inferne et sparsius lamina ferrugineo-squamulosis, acumine 3-4 cm longo basi 6 mm lato argute serrato dentibus inflexis; venulis spuriis ambabus faciebus et luce transeunte subconspicuis; soris vix 1 mm a margine remotis, 1-1.5 mm longis, sporangiis 7-10, apices versus pinnularum soris more Danaeae orbicularibus, haud ad acumina attingentibus.

Pitcairn: hills above Adamstown, wet wooded ravine, altitude 100 meters, Fosberg and Christian no. 11242, type; Garnets Ridge, moist woods, altitude 150 meters, St. John no. 14990. Local name, *nehe*.

The species is well characterized by the broad, sterile apices of the pinnules, with sharp, narrow, incurved teeth at their bases.

Marattia cincta Copeland.

Raiatea, no. 17266.

Endemic.

M. Stokesii E. Brown.

Rapa, no. 15354. Endemic.

Locules not rarely 12. This is ill distinguished from Tahitian *M. fraxinea,* but more than one species may still be included under that name.

HYMENOPHYLLACEAE[2]

Hymenophyllum polyanthos Swartz.

Hymenophyllum gracilius Copeland.

Tahiti, nos. 17035, 17431.

Pantropic.

H. cuneatum Kunze.

Rurutu, no. 16750; Rapa, nos. 11386, 11564, and 15436.

Chile, Juan Fernandez.

Construing *M. polyanthos* as broadly as I do, *M. cuneatum* is not very distinct from it.

Mecodium diversilabium Copeland, new species (pl. 2).

Rhizomate filiforme vix 0.2 mm diametro; stipitibus filiformibus, 6-10 mm longis, vix ad basin alatis, atrocastaneis, basi decidue piluliferis; fronde 2-3 cm longa, 1.5-2 cm lata, apice rotundata, tripinnatifida, compacta, segmentis uninerviis brevibus 1 mm latis rotundatis vel emarginatis, sordide viridibus, costis aut fuscis aut rubido-fuscis, ad bases sororum ramiferis; soris terminalibus, multis, involucro ca. 1-2 mm lato, paullo longiore, ad vel ultra medium fisso, labiis diversis, plerisque lobato-dentatis lobis ca. 3 rarius integris acutis, rarissime integris rotundatis, nonnullis profundius in segmenta involucri 3, 4 vel 5 divisis; receptaculo columnare valido vix ultra mediam longitudinem involucri extenso.

Austral Islands: Tubuai, northeast slope of Taitaa, in moist shaded crevices between basalt ledges, altitude 375 meters, St. John no. 16438, type; same locality, altitude 390 meters, St. John and Wight no. 16313.

Probably a derivative of the variable species here called *M. cune-*

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[2] In a paper prepared before this one, but still awaiting publication in the Philippine Journal of Science, I recognize some thirty genera in this family. To avoid the use of unfamiliar names without the argument which would justify their use, I retain here *Trichomanes* and *Hymenophyllum* as names of old species and thus avoid new combinations. For new species, however, I am unwilling to pile up synonyms by using these generic names for species which do not properly belong in the genera. To validate the new generic names used here, the following brief references or diagnoses will serve:

Mecodium Presl is taken from Epimeliae Botanicae (1851 ?), p. 258.

Callistopteris: Rhizomate valido, stipitibus caespitosis setosis, frondibus magnis decompositis membranceis, involucris obconicis, receptaculo exserto. Type, *Trichomanes apiifolium* Presl.

Macroglena is used by Presl (Abh. Böhm. Gesell. Wiss., ser. 5, vol. 5, p. 333, 1848) as the name of a section of *Trichomanes.* I give it generic status, typified by *T. meifolium* Bory.

atum (Cavanilles) Copeland, but distinct from other local forms in aspect, as well as in the remarkable lips.

Trichomanes humile Forster.

Tahaa, no. 17356.

Westward to Sumatra and Formosa.

T. Endlicherianum Presl.

Raivavae, no. 16188; Rurutu, no. 16630. Rapa, nos. 11592, 15328, 15390.

New Zealand, Norfolk, Fiji, Samoa, Tahiti.

I have seen no specimen from Fiji or Tahiti except Brackenridge's types of *Trichomanes erectum* and *T. tenue* ascribed to these islands.

Pleuromanes pallidum (Blume) Presl.

Tahiti, no. 17053.

Marquesas to Ceylon.

Trichomanes polyanthum Hooker.

Tahiti, no. 17072.

Endemic in the Society Islands.

T. Bauerianum Presl.

Rurutu, no. 16751.

The specimen is too young for positive determination.

Callistopteris calyculata Copeland, new species (pl. 3).

Fronde 25-30 cm longa, 10-15 cm lata; pinnis basalibus paucis modo reductis, suprabasalibus 6-9 cm longis 2.5-3 cm latis; segmentis ultimis vix 1 mm latis; soris in segmenta fere abortiva immersis deinde alatis, late calyciformibus, indusio vix 1 mm longo, paullo latiore, tenuiter membranaceo et fragile, ore breviter bilobo, receptaculo tantum aequilongo.

Rapa: Kaimaru, south ridge of Mount Perahu, moist soil in dense woods on ridge, altitude 475 meters, St. John and Maireau no. 15522, type; also, west slope of Vairu, bottom of moist ravine, altitude 330 meters, Fosberg no. 11614. St. John and Maireau no. 15435, juvenile, is presumably this species.

This is another local insular species, characterized by the broad sori, with rounded, immersed base and shallowly bilabiate mouth. It is nearest to *C. polyantha,* but with smaller sori and less narrowed base of frond. *C. polyantha* is typically developed in Huahine and Raiatea, Tahiti specimens varying toward *C. calyculata.*

Trichomanes dentatum van den Bosch.

Tahiti, no. 17054; Raiatea, no. 17281; Tahaa, nos. 17343, 17365; Tubuai, no. 16427; Rurutu, no. 16753. Rapa, no. 15661.

Westward to New Caledonia.

Macroglena truncata Copeland, new species (pl. 4).

Rhizomate repente, 1 mm crasso, nigro, apice basibusque stipitum pilis atrocastaneis usque ad 1 mm longis mox detersis vestitis; stipitibus haud remotis 4-8 cm longis, ca. 0.7 mm crassis castaneis sursum viridescentibus; fronde usque ad 16 cm longa et 6 cm lata, tripinnatifida segmentis interdum furcatis, rhachi deorsum angustissime sursum rhachibusque pinnarum latius alatis, segmentis ca. 0 6 mm latis; cellulis utroque latere costae 3-4-seriatis, magnis, parietibus modo incrassatis obscuris, cellulis marginalibus parietibus tenuibus; soris paratactis a margine frondis remotis, involucro cylindrico 1.5 mm longo, 0.5 mm lato, basi alato, ore truncato haud expanso, receptaculo duplo quam involucro longiore.

Rapa: Mitiperu, in dense damp forest, altitude 350 meters, Fosberg no. 11573, type; Kaimaru, south ridge of Mount Perahu, on tree trunks, altitude 460 meters, St. John and Maireau no. 15527; Hiri Valley, south slope of Morongota, on trunks in dense forests, altitude 150 meters, Fosberg no. 11593, juvenile.

A relative of *M. caudata* (Brackenridge) Copeland, and like that species in having a better laminar development than is typical of *Macroglena*, but with the large cells typical of the genus; different from the smaller forms of *M. caudata* (*Trichomanes Milnei*) in having the involucre wingless except at the base, and the mouth not at all dilated. The gross appearance is that of *Trichomanes johnstonense* Bailey, which is near to *T. maxima,* ascribed to Rapa by Dr. and Mrs. F. B. H. Brown (Bishop Museum Bull. 89, p. 10, 1931), but the cellular structure is altogether different.

Schizaeaceae

Schizaea dichotoma (Linnaeus) Smith.

Raiatea, no. 17330; Huahine, no. 17201; Tahaa, no. 17374.

Westward to Madagascar.

S. fistulosa Labillardière.

Raiatea: Temehani Plateau, in high moor, altitude 600 meters, St. John no. 17300.

Collected in the Society Islands by Brackenridge (as *S. australis,* regarded as a variety of *S. fistulosa*), but overlooked in Bulletin 93.

I cannot distinguish *S. robusta* Baker, described from Hawaii and accredited to the Society Islands on the strength of the Brackenridge collection. The distribution is typically austral—Antarctic America, Norfolk, New Zealand, Tasmania, north to New Caledonia; reported also from Borneo and the Seychelles, and (evidently in error—see Christensen, Pteridophyta of Madagascar, p. 174) from Madagascar. The Borneo plant is probably *S. malaccana* Hooker—or *S. Copelandica* Richter if that be distinguishable.

Lygodium reticulatum Schkuhr.

Huahine, no. 17191; Tahaa, no. 17366.

Very common in western Polynesia and to Australia, but unknown farther east.

GLEICHENIACEAE

Gleichenia Brackenridgei Fournier.

Tahiti, nos. 16987, 17003, 17107.

Fiji, New Caledonia.

G. tahitensis Copeland.

Tahiti, no. 17107.

Endemic.

G. linearis (Burmann) Clarke.

Tahiti, nos. 14135, 17094; Tahaa, no. 12139; Rurutu, no. 16575; Tubuai, no. 16457; Raivavae, nos. 15830, 15840; Rimatara, no. 12045; Rapa, nos. 11377, 11425, 11443, 11479, 11566; Mangareva, nos. 14462, 14931; Pitcairn, nos. 11221, 14955.

MARSILEACEAE

Marsilea polycarpa Hooker and Greville.

Borabora: Turapuo, in swampy flat by shore, abundant, St. John and Fosberg no. 17414.

Tropical America, already reported from the Society Islands by Baker. I mistrust the identification, but cannot correct it.

POLYPODIACEAE

Cyathea affinis (Forster) Swartz(?).

Tahiti, no. 14145, sterile.

C. tahitensis (Brackenridge) Domin.
Huahine, no. 17155; Raiatea, no. 17269.
Endemic in Society Islands.

C. societarum Baker.
Tahiti, no. 14151.
Endemic (but see note under *C. rapensis*).

C. Cumingii Baker.
Rurutu, no. 16659; Tubuai, nos. 16332, 16361; Pitcairn, nos. 11241, 14978 (see note under *C. rapensis*).

Cyathea rapensis Copeland, new species (pl. 5).

Trunco teste lectore 6 m alto; stipite 30 + cm alto, castaneo, basi paleis lineari-acicularibus 25 mm longis margine deorsum breviter fimbriatis vestito, sursum minute tuberculato furfuraceo; fronde 120 cm longa, 90 cm lata, subtripinnata, rhachibus castaneis asperulis; pinnis infimis 40 cm longis recurvis, longe (5 cm) stipitulatis, medialibus brevius stipitulatis, 50 cm longis, 20 cm latis, abrupte acuminatis; pinnulis infimis paullo reductis stipitulatis, sequentibus 10.5 cm longis, 3 cm latis, subsessilibus, imbricatis, basi pinnatis rhachibus (et pinnarum) superne et pilis et paleis minutis angustis castaneis dense vestitis inferne sparsius furfuraceis; pinnulis II resp. segmentis usque ad 2 cm longis, 3-4 mm latis, acutis, majoribus crenatis, omnibus apices versus serrulatis, coriaceis, glabris, laete viridibus; venulis ca. 15-paribus, inferioribus bis dichotomis soris costularibus, indusio brunneo, vix 1 mm lato, oblique versus marginem dehiscente.

Rapa: Maungaeae, east of Mangaoa Peak, in dense moist woods, altitude 260 meters, St. John and Maireau no. 15355, type; Anarua Valley, southeast ridge of Mount Perahu, altitude 300 meters, Fosberg no. 11511, stipe 70 cm long, frond 80 cm long; Peatuakaviri, west of Mount Tautautu, altitude 210 meters, St. John and Maireau no. 15397, trunk 10 meters tall, fronds larger throughout than as described, axes more muricate and more scurfy, indusium opening almost upward. No. 15397 may be the Rapa plant identified by Mrs. Brown as *C. medullaris,* from which it differs in being much more scurfy. Its fruiting fertile pinnules are freely inciso-crenate, but crenation occurs in New Zealand also.

What I determine as *C. medullaris* occurs from New Zealand to Australia and the New Hebrides. All species from Tahiti east and south, except *C. decurrens* are its relatives. *C. societarum* and *C. Cumingii* are hardly distinguishable; since the latter name exists, I apply it to specimens from the Austral Islands and Pitcairn, but the covering of the dorsal surface by the sori, which Baker emphasized

and Mrs. Brown used as a key character is unlikely to be peculiar to anything except single specimens. *C. tahitensis* is well marked by the conspicuously one-sided indusium; but the tendency in all of these species is for the indusium to break down first on the most exposed side. Thus, on a single pinnule of *C. rapensis*, where the sori are on one side of the costa, they rupture almost upward, but where as is usual they are on both sides, the rupture shifts to the marginal side of the indusium.

If no. 15397 were from another island, I might describe it as another species, but I anticipate that when many Rapa specimens can be compared, they will be found to intergrade. The collection of this number is very ample otherwise, but wants the stipe. The basal scales of the other two collections are narrower and darker than in related species.

Dryopteris sciaphila Maxon.

Raivavae, no. 15858; Rurutu, no. 16663; Rapa, no. 15245; Pitcairn, no. 14968.

Described from Tahiti.

D. dicksonioides (Mettenius) Copeland.

Tahiti, no. 17034.

D. setigera (Blume) O. Kuntze.

Raivavae, nos. 11672, 11777, 15987; Rurutu, no. 16578.

Native westward to India and to Japan.

D. leucolepis (Presl) Maxon.

Borabora, no. 17423; Raivavae, no. 11672; Rapa, no. 15717.

Westward to the Philippines.

Dryopteris diversisora Copeland, new species (pl. 6).

Rhizomate erecto, cum basibus stipitum vix 2 cm crasso; stipite erecto, 30 cm alto, fusco, dense breviter pubescente, deorsum paleis membranaceis brunneis 5 mm longis, 2 mm latis acutis aut integris aut sparsissime dentiferis sat dense vestito, sursum rhachique sparsius paleis decrescentibus vestitis; fronde usque ad 35 cm longa, 14 cm lata, acuminata, subbipinnata; pinnis infimis deflexis non reductis, pinnulis infimis reductis; medialibus horizontalibus, 7 cm longis, vix 2 cm latis, acutis, sessilibus basi haud angustatis, basi vel nullibi pinnatis alibi profunde pinnatifidis, rhachibus pubescentibus inferne cum paleis minutis pilis immixtis; segmentis 3-4 mm latis, apice rotundatis, crenulatis vel inferioribus crenatolobatis, herbaceis, costis utraque facie et margine setiferis; venis ca 6-paribus, infima rhachiscopica plerumque furcata; soris medialibus, indusio aut asplenioideo aut athyrioideo aut rarius symmetrice hippocretiforme bullato non glandulifero.

Rapa: Taratika, east side of Mount Perahu, rain forest on main ridge, altitude 620 meters, St. John, Fosberg and Maireau no. 15660, type; west ridge of Mount Perahu, rain forest, dense shade, altitude 630 meters, St. John and Fosberg no. 15723.

A relative of *D. viscosa,* from which it differs in having broader basal scales and fairly abundant smaller scales mixed with the pubescence of the rachises of frond and pinnae. *D. Quaylei* of the Marquesas is probably in the same group.

In general, the lower sori are dryopteroid and the distal ones asplenioid; the occasional dominance of the latter is shown by the field label of no. 15723, bearing the name *"Asplenium"*.

Dryopteris rurutensis Copeland, new species (pl. 7).

Rhizomate horizontale apice erecto, radicibus basibusque stipitum profunde immerso iisdemcumque 5 cm crasso; stipitibus fasciculatis, validis, sulcatis, stramineis, decidue puberulis; fronde usque ad 120 cm longa, 35 cm lata, pinnata, pinnis infimis sensim ad vestigia pauca remota reductis; pinnis medialibus 20 cm longis, 15-18 mm latis, sessilibus, basi truncatis acroscopice paullo dilatatis, apice sensim attenuatis, medio ad costam vel profundius pinnatifidis, herbaceis, costa superne pubescente excepta omnino glabris; segmentis 3-4 mm latis, obliquis, obtusis; venis 8-10-paribus, infimis prope costam anastomosantibus et costulam validam in dentem deflexum sinum complentem cum venis (non paribus) 1 vel 2 sequentibus connexum terminantem producentibus; soris ad venas fere omnes medialibus, indusio nullo vel vestigiale.

Austral Islands: Rurutu, Moerai, on moist shaded stream bank, altitude 15 meters, St. John and Fosberg no. 16590.

Related to *D. Stokesii,* but with fewer anastomosing veinlets, larger, and less scaly at the base.

D. Grantii Copeland.
Tahiti, no. 17111.
Local.

D. Margaretae E. Brown.
Rapa, nos. 11429, 11544, 11549, 15710.
Endemic.

D. gongylodes (Schkuhr) O. Kuntze.
Rurutu, no. 16683; Rimatara, no. 16933.
Pantropic.

D. Stokesii E. Brown.
Rapa, nos. 11473, 11548, 15250.
Endemic.

The rhizome is creeping and, like the bases of the closely placed stipes, clothed with lanceolate to ovate fuscous paleae. The stipes may be 7 mm in diameter, but not 7 cm as described. In the specimens in hand, the transition from normal pinnae to tubercle-like rudiments is abrupt. A vestigial indusium can be detected before but not after the sporangia develop. The author of the species makes the indusium persistent in her key, but "absent, at least on mature fronds" in the description; and names it with a masculine genitive, presumably for Mrs. Stokes.

D. invisa (Forster) O. Kuntze.

Borabora, no. 12164. Raivavae, nos. 11682, 15837; Tubuai, no. 16490; Rimatara, no. 16941.

Marquesas to New Caledonia.

D. unita (Linnaeus) O. Kuntze.

Tahaa, on an islet in Haamene Bay, on open grassy slope, altitude 5 meters, Fosberg no. 12148; previously reported by Drake.

Westward to India and the Seychelles.

D. Haenkeana (Presl) O. Kuntze.

Tahaa, east side of Mount Purauti, moist woods, altitude 220 meters, St. John no. 17359.

This is the plant so named from Fiji and New Caledonia.

Dryopteris dentata (Forskål) C. Christensen.

D. nymphalis (Forster) Copeland.

Mangareva Islands, nos. 14483, 14613, 14728, 14773, 14938; Pitcairn, nos. 11230, 11231, 14949, 14965; Raivavae, no. 11678; Rapa, nos. 11485, 15333.

With a limited number of specimens from Tahiti and Fiji, I have thought it possible to distinguish the Polynesian plants once called *D. parasitica, Aspidium molle,* etc., from those of Malaya, Africa, and America. With the more ample material now demanding identification, I find that a strict interpretation of *D. nymphalis,* in which sense only it can be distinguished from *D. mollis,* will exclude many nearly related specimens. These might then be described as other species, or given other old names; and at least in part these are indistinguishable from American forms which seem unsusceptible of specific distinction from *D. mollis.* Therefore, I am driven to the conclusion that the best course is to recognize the group as very variable in Polynesia and

to abandon the attempt to distinguish it from the likewise variable American species named (*Polypodium molle* Jacquin) a few years later. I do not know authentic *D. dentata,* but accept Christensen's use of the name.

The material now given this name is all somewhat hispid on both surfaces as well as on the veins and indusia; has one, or two pairs of anastomosing veinlets; the rhizome is creeping, moderately or very stout, sometimes erect at the tip; stipes fascicled or at any rate not very remote, with narrow dark entire scales at the base; the lowest pinnae usually but not invariably reduced.

The geographic varieties (of *D. parasitica*), *pitcairnensis, rapensis,* and *mangarevensis* E. Brown (Bishop Museum Bull. 89, p. 23, 1931), do not exist as fixed local forms. From each of the islands in question, we have specimens not fitting her descriptions. As small as Pitcairn Island is, the four collections from it might all be distinguished in words.

D. sulphurea E. Brown.

Rurutu, nos. 11937, 16636; Rimatara, no. 12053; also Meetia, no. 14189, which would be *D. subpectinata* if it bore basal abortive pinnae. The latter species is perhaps not constantly different.

Described from the Marquesas.

Polystichum aristatum (Forster) Presl.

Rurutu, no. 16673. Rapa, no. 15249. Pitcairn, nos. 11229, 11310, 14969.

Westward to Japan and Natal.

P. rapense E. Brown.

Rapa, nos. 11508, 11624, 15244, 15596.

Endemic. This was described from stunted specimens like no. 11624; our other collections have fronds 35 cm long, and no. 11508 is tripinnate.

P. Stokesii E. Brown.

Rapa, nos. 11604, 15366, 15524, 15673.

Endemic.

Polystichum Australium Copeland, new species (pl. 8).

Rhizomate adscendente 2 cm crasso, cum radicibus basibusque stipitum, 6 cm crasso; stipite 35 cm alto, deorsum paleis fuscis 2 cm longis, 3-5 mm latis acuminatis basi aut integris aut ramuliferis densissime, sursum sparsius paleis

stramineis 2-4 mm longis lanceolatis acuminatis margine leviter fimbriatis vestito; fronde 60 cm alta, 35 cm lata, tripinnata, rhachi straminea fibrillosa glabrescente; pinnis infimis patentibus paullo reductis, medialibus usque ad 22 cm longis, 5 cm latis acuminatis; pinnulis 3 cm longis, 8 mm latis, basi obliquis subauriculatis subcoriaceis, glabrescentibus, pallide viridibus; soris multis, parvis, submarginalibus, leviter immersis sed superne conspicue umbonatis, indusio sat grande integro.

Austral Islands: Raivavae, Mount Taraia, south slope, woods at base of precipice, altitude 230 meters, St. John no. 16009, type; Raivavae, Mount Muanui, south slope, dense woods at base of cliff, altitude 200 meters, Fosberg no. 11699; Tubuai, Taitaa, moist upper woods between basalt cliffs, altitude 370 meters, St. John no. 16439.

This species is a relative of *P. rapense,* more naked than the ample forest form of that species, with narrower pinnules, and the sori conspicuously embossed on the upper surface.

Polystichum paleatum Copeland, new species (pl. 9).

Rhizomate (test. lectoribus) erecto et 0.5 m. alta; stipite 50 cm alto, densissime paleaceo, paleis 10 cm supra basin stipitis 4 cm longis 5 mm latis sensim acuminatis fuscis margine brunneis integris vel basi imo ramuliferis, ad basim stipitis conformibus minoribus, sursum diversissimis maximis 18 mm longis, 8 mm latis cum aliis aequilongis lanceolatis et minoribus et minutis aut supra basin integris aut ubique ornatim dissectis mixtis; fronde 80 cm longa, 30 cm lata, subtripinnata, rhachi dense paleacea paleis laete brunneis, majoribus deorsum ovatis sursum lanceolatis decrescentibus basi ramuliferis cum minoribus plus dissectis et usque ad pila reductis mixtis; pinnis infimis deflexis 8 cm longis bipinnatifidis, medialibus 16 cm longis, 4 cm latis, rhachibus et paleis linearibus et pilis stramineis vestitis; pinnulis II inferioribus basi obliquis pinnatis alibi aut pinnatifidis aut incisis; soris parvis, indusiis minoribus fuscis margine leviter inciso-crenatis persistentibus.

Tahiti: Orofena, south ridge, dense upper rain forest, altitude 1600 meters, St. John and Fosberg no. 17014.

This must be the plant reported by Drake del Castillo (Flora Polyn. Franc., p. 297, 1893), as *P. aculeatum,* collected by Nadeaud. In Bulletin 93, p. 40, I listed this without seeing it, and printed the description of the Fiji species of the same group. As far as that description went, it is reasonably appropriate, but the Fiji plant is smaller and incomparably less scaly.

Tectaria tenuifolia (Mettenius) Maxon.

Tahiti, no. 17105; Tubuai, no. 16444.

Previously known from Tahiti only.

T. tahitensis Maxon.
Tahaa, no. 17401.
Endemic in the Society Islands.

T. decurrens (Presl) Copeland.
Tahiti, no. 14167.
Westward to Ceylon.

Athyrium congruum (Brackenridge) Copeland.
Tahiti, nos. 17036, 17080, 17126, all from Orofena, altitude 1,220-1,600 meters.
Samoa, Fiji, New Caledonia. This is presumably the plant cited as *A. japonicum* by Drake.

A. polyanthes (Solander) Copeland (uncertain, in the absence of basal paleae).
Raivavae, no. 16003.
Society Islands, Marquesas, Rapa (see Bulletin 89).

A. membranaceum (Mettenius) Copeland, new combination.[3]
Asplenium membranaceum Mettenius: in Kuhn, Linnaea, vol. 36, p. 103, 1869.
Rurutu, no. 16660; Rapa, nos. 11470, 15254, 15349, 15447.
Pitcairn, Coral Island, Samoa (?).

Athyrium Sancti-Johannis Copeland, new species (pl. 10).

Caudice erecto; stipite 80 cm alto, basi 15 mm crasso atropurpureo paleis nigris lanceolatis margine minute spinuliferis deciduis ornato, inerme sursum brunnescente; fronde 1.5 m. alta, 80 cm lata, basi vix angustata, tripinnatifida, rhachibus glabris, stramineis superne sulcatis; pinna mediale 45 cm longa, 20 cm lata, breviter (1 cm) pedicellata; pinnulis remotis, brevissime pedicellatis, usque ad 11 cm longis, 2-3 cm latis, acuminatis, profunde oblique pinnatifidis, herbaceis; segmentis 5-7 mm latis, subacutis, serrulatis; venulis remotis, 6-7-paribus, rectis, omnibus (in fructificatione plena) soriferis, soris e costa ad marginem protensis, angustis, infimo acroscopico diplazioideo, indusio angustissimo pallido persistente integro.

Austral Islands: Tubuai, northeast slope of Taitaa, in shaded cleft between basalt rocks, altitude 380 meters, August 20, 1934, St. John no. 16440.

Distinguished from *A. membranaceum,* as I construe that species, by being more ample throughout, with larger, fewer, and more oblique segments.

[3] Director Diels has compared these specimens with Mettenius' type and informs me that they are distinct, as is also the following species.

Athyrium pitcairnense Copeland, new species (pl. 11).

Caudice valido adscendende; stipite 35-40 cm alto, basi fusco paleis brunneis membranaceis et ovatis et lanceolatis usque ad 4 mm longis acuminatis fragilibus margine minutissime spinuliferis haud dense vestito, sursum rhachibusque stramineis nudis; fronde ca. 40-50 cm longa, 20-25 cm lata, acuminata, bipinnata; pinnis infimis plerumque deflexis 9 cm longis, 3 cm latis, medialibus 15-17 cm longis, 5-6 cm latis, caudatis, breviter (5 mm) stipitulatis, basi non angustatis; pinnulis liberis ca. 7-paribus, maximis 3 cm longis, 1 cm latis, sessilibus et plerisque adnatis, obtusis vel rotundatis, inferioribus inciso-serratis, aliis serratis, tenuiter papyraceis, olivaceo-viridibus; venis in lobis pinnatis, in dentibus furcatis vel simplicibus; soris patentibus, 2-3 mm longis, indusio angusto.

Pitcairn: Outer Valley, on steep wooded slope, altitude 220 meters, June 14, 1934, Fosberg and Clark no. 11308.

The large group of related species includes *A. ellipticum* of Tahiti, from which this species differs in being more dissected throughout.

Athyrium tenuipaleatum Copeland, new species (pl. 12).

Caudice suberecto, radicibus basibusque stipitum occulto; stipite 25-35 cm alto, basin versus nigrescente paleis atris 10-15 mm longis, 1 mm latis aciculari-protensis fere integris vestito, sursum stramineoviride, glabro; fronde ca. 60 cm longa, 40 cm lata, acuminata, bipinnata; pinnis infimis fere 20 cm, sequentibus 23 cm longis, valde acuminatis, 8 cm latis, stipitulis 7 mm longis; pinnulis liberis ca. 8-paribus, infimis sessilibus aliis plus minus adnatis, usque ad 4.5 cm longis, 1 cm latis, acutis vel obtusis, infimis inciso-lobatis, sequentibus inciso-serratis superioribus serratis, papyraceis, laete viridibus: soris 3-4 mm longis, patentibus, indusio brunneo.

Rapa: southeast slope of Mount Ororangi, dense forest on steep slope, altitude 265 meters, July 6, 1934, F. R. Fosberg no. 11415.

Very near to *A. pitcairnense,* from which it differs essentially in the basal scales; also, it is more ample, clear green, and with less reduced basal pinnae.

Athyrium Fosbergii Copeland, new species (pl. 13).

Rhizomate repente, 1 cm crasso, lignoso, basibusque stipitum paleis paucis, caducis onustis; stipitibus haud remotis, 60-70 cm altis, fuscis, nudis; fronde ca. 60 cm longa, ovata, acuminata, tripinnata; pinnis remotis, inferioribus 30 cm longis stipitulis 3 cm longis, 12 cm latis, acuminatis; pinnulis etiam remotis, infimis 4.5 cm longis stipitulis 2 mm longis, sequentibus 6.5 cm longis, 2.5 cm latis, subacuminatis, basi pinnatis pinnulis II leviter incisis, deinde pinnatifidis segmentis decurrenti-connexis 10-12 mm longis, 4-5 mm latis, integris apice rotundatis, papyraceis; venis furcatis vel triramiferis; soris costalibus, oblongis, ca. 2 mm longis, indusio laete brunneo persistente.

Rapa: Mitiperu, Maungaeae ridge among ferns, altitude 300 meters, July 18, 1934, F. R. Fosberg no. 11577.

Nearly related to *A. Grantii* of Tahiti, but more lax and less dissected.

A. rapense (E. Brown) Copeland, new combination.

Diplazium rapense E. Brown: Bishop Museum Bull. 89, p. 57, pl. 11, 1931.

Rapa, no. 15672.

Endemic.

Athyrium subquadripinnatum Copeland, new species (pl. 14).

Caudice erecto, 20 cm alto, radicibus validibus basibusque stipitum frondium emortuarum profunde immerso: stipite 50-60 cm alto, basi 7 mm crasso, nigro, basi paleis paucis caducis onusto alibi glabro; fronde 70 cm longa, 60 cm lata, late ovata, fere quadripinnata, rhachibus fuscis nudis; pinnis inframedialibus maximis, 34 cm longis, 15 cm latis, breviter (15 mm) stipitulatis, brevi-acuminatis; pinnulis infimis 5 cm longis, medialibus 7.5 cm longis, 2.5-3 cm latis, acutis, stipitulis 5 mm longis; pinnulis II ca. 15 mm longis, vix 1 cm latis, apice rotundatis et dentatis, breviter (1 mm) pedicellatis, basi fere pinnatis, segmentis ca. 3-paribus, 2-4 mm latis, cuneato-ellipticis, infimis crenato-lobatis, membranaceis, inferne paullo pallidioribus; soris costalibus, ca. 1-5 mm longis, plerisque rectis simplicibusque.

Austral Islands: Rurutu, north side of Moerai, in shaded crevice between ledges of coral cliffs, altitude 10 meters, August 25, 1934, St. John no. 16640. The type consists of one complete frond mounted on five sheets.

A. javanicum (Blume) Copeland.

Tahiti, no. 17113.

Westward to India.

Blechnum orientale Linnaeus.

Tahaa, no. 17334; Raivavae, no. 15833; Rurutu, no. 16570; Tubuai, no. 16338; Rimatara, no. 12054; Rapa, nos. 11374, 15246; Mangareva, nos. 11106, 14563, 14885. The field note of no. 12054 states that the erect caudex is 2 meters high.

Westward to India.

B. capense (Linnaeus) Schlechtendal.

Tahiti, nos. 17082, 17114; Rapa, nos. 11567, 11601, 11605, 15293.

B. vulcanicum (Blume) Kuhn.

Tahiti, nos. 11733, 16986; Rapa, nos. 11576 (variety *rapense* E. Brown), 11608; all being of the rather glabrous form already familiar in the Society Islands.

New Zealand to Java and Luzon; Marquesas.

Blechnum venosum Copeland, new species (pl. 15).

Lomaria, caudice adscendente, vero 1-1.5 cm crasso sed cum radicibus basibusque stipitum 5 cm crasso, apice paleis lineari-aciculatis 17 mm longis castaneis nitidis immerso; stipite frondis sterilis 15-20 cm longo, rigido, paleis atrocastaneis 10 mm longis basi 1.3 mm latis apice acicularibus densissime obtecto; fronde 30 cm alta, abrupte acuminata, basi truncata, dura et fragile, pinnata, rhachi paleis deorsum 6 mm longis dense vestita sursum glabrescente asperula; pinnis contiguis, horizontalibus, acutis vel acuminatis, margine cartilagineis, inferioribus 12 cm longis, 16 mm latis, basi basiscopice rotundato-auriculatis supra rhachin imbricatis acroscopice (infimis uniparibus exceptis) adnatis, superioribus utroque latere adnatis, venis congestis superne in sulcis immersis, inferne praestantissime salientibus; fronde fertile longius stipitatis, pinnis usque ad 10 cm longis, cum indusiis elatis 5 mm latis.

Rapa: Taratika, east side of Mount Perahu, moist bank in rain forest, altitude 550 meters, St. John, Fosberg and Maireau no. 15651.

An isolated member of the group of *B. vulcanicum*, as shown by form of frond, attachment of pinnae, and roughness of stipe and rachis after the naturally persistent paleae are removed. The fronds and pinnae are so brittle that almost all are broken.

B. attenuatum (Swartz) Mettenius.

Tahiti, no. 17041; Raivavae, no. 16168; Rurutu, no. 16670; Tubuai, nos. 16338, 16434; Rapa, nos. 11568, 11590, 11613, 15313, 15655—all alike in having the lowest normal pinnae reduced and deflexed, with truncate-flabellate rudiments on the stipe—11603, 15631 (abruptly contracted at base), 15530, 15659—base gradually narrowed.

Mauritius to South Africa; Australia; South America (?).

B. Patersoni (R. Brown) Mettenius.

Tahiti, no. 16997.

New Zealand to India.

Doodia media R. Brown.

Raivavae, nos. 11671, 11775; Rurutu, no. 16661; Rapa, nos. 11517, 11556, 15367, 15518, 15608; Pitcairn, nos. 11228, 14976.

The Rurutu specimen may be *D. marquesensis*. My present impression of Polynesian *Doodia* is that the local difference between individuals is greater than that between the considerable number of proposed species.

Asplenium rapense (E. Brown) Copeland, new combination.
Asplenium Macraei, variety *rapense* E. Brown (Bishop Museum Bull. 89, p. 65, 1931).

Ab *Asplenio Macraei* Hooker et Greville frondibus brevioribus uniformibus fere tripinnatis segmentis minoribus, stipitibus distinctum. Stipite castaneo, usque ad 7 cm alto deorsum paleis angustis 2.5 mm longis persparsis vestito; fronde 15-20 cm longa, 5 cm lata, membranacea.

The type is Stokes no. 224. Specimens in hand are from Rapa: St. John and Maireau no. 15417; Toutore, west end of Mount Vaitau, mossy rock in moist forest, altitude 240 meters, St. John and Anderson no. 15615; Maitua Valley, on shady, mossy rocks, altitude 230 meters, St. John and Maireau no. 15625, north slope of Mount Lekie, on moist basalt precipice, altitude 320 meters.

A. Macraei is very variable in dissection, at most being almost tripinnate, but then with larger and thicker segments. Its less cut forms approach *A. erectum* Bory. It does not appear to me that that is the affinity of *A. rapense; A. Hookerianum* of New Zealand is a more probable relative.

A. lucidum Forster.

Raivavae, nos. 15857, 16045; Tubuai, no. 16359; Rurutu, no. 16674; Rapa, no. 15566.

New Zealand, Tasmania, Marquesas.

A. obtusatum Forster.

Rurutu, no. 16642; Rapa, nos. 15493, 15547; Marotiri, no. 15689; Mangareva (Makaroa), no. 14743; Pitcairn, nos. 11291, 11343.

New Zealand, Chile, northward to Hawaii.

A. falcatum Lamarck.

Rapa, nos. 11439, 11507, 11515, 11557, 11615, 11633, 15263, 15630.

New Zealand and Polynesia to India and Africa.

A. caudatum Forster.

Tahiti, no. 17050.

Asplenium indusiatum Copeland, new species (pl. 16).

Rhizomate repente, 1 cm crasso, basibusque stipitum paleis castaneis anguste lanceolatis 7 mm longis striatis apice elongatis vestitis; stipitibus vix 1 cm inter se remotis, 30 cm altis, pallide viridibus sursum glabris; fronde 45-50 cm alta, 25 cm lata, basi truncata, pinnata, segmento apicale triangulare; pinnis

15-20-paribus, inferioribus 13 cm longis, 2 cm latis, sursum decrescentibus, acuminatis, basi basiscopica cuneatis acroscopica truncatis, leviter incisis vel tantum inciso-serratis, infimis rarius rhachin versus pinnatis pinnulis sessilibus 2 cm longis, 12 mm latis, apice rotundatis dentatis basi cuneatis, subcoriaceis, glabris, viridibus; venis obliquis, furcatis; soris obliquis, inferioribus 15 mm longis, indusiis conspicuis, persistentibus, aut ubique aut linea insertionis atrocastaneis vel atris.

Mangareva: Mount Mokoto, upper forest, in moist old woods, altitude 320 meters, St. John no. 14854, type; also, Tubuai, Taitaa, dense upper forest, altitude 320 meters, St. John no. 16346.

All species of *Asplenium* are indusiate, but this specific name does not overemphasize the remarkably conspicuous indusia of this species. The group is that of *A. falcatum*. The pinnae of the Tubuai specimen are in form quite like those of *A. acutiusculum* Blume, but the sori are very different.

A. horridum Kaulfuss.

Raivavae, nos. 11891, 16010 (fronds 15-20 cm long), 16167 (frond 140 cm long, on long stipe); Tubuai, no. 16328; Rapa, nos. 11560, 15526.

Polynesia, described from Hawaii; westward range questionable.

A. laserpitiifolium Lamarck.

Raiatea, no. 17236; Tubuai, no. 16333.

Westward to the Seychelles.

A. (Loxoscaphe) gibberosum (Forster) Mettenius.

Tahiti, nos. 16999, 17038; Tahaa, no. 17403; Tubuai, no. 16334; Raivavae, nos. 11776, 16054; Rapa, nos. 15242, 15649; Mangareva, no. 14852; Pitcairn, nos. 11297, 14967, 15002.

Westward to Fiji.

A. (Thamnopteris) Nidus Linnaeus.

Borabora, no. 17416; Huahine, no. 17185; Meetia, no. 14233; Rimatara, no. 16875; Rurutu, no. 16638; Tubuai, no. 16360; Maria, nos. 12083, 12104, 12109, 16951; Raivavae, nos. 15855, 16164; Anaa, no. 14261; Rapa, nos. 11493, 15241; Mangareva, no. 14471; Pitcairn, no. 14970; Oeno, no. 15184; Henderson, no. 15088.

Westward to Africa.

Lomagramma Wilkesiana (Brackenridge) Copeland.

Rurutu, no. 16771; Raivavae, nos. 16004, 16037.

Society Islands, Rarotonga, New Caledonia, everywhere similarly polymorphous.

Nephrolepis biserrata (Swartz) Schott.

Rimatara, no. 16794; Tubuai, no. 16209; Maria, nos. 12098, 12107, 16954; Raivavae, nos. 16034, 16143; Mangareva, nos. 14458, (Aukeua) 14615; Henderson, nos. 11345, 15087, 15143.

Pantropic.

N. exaltata (Linnaeus) Schott.

My use of this name here is no more than conventional, and *N. biserrata* and *N. hirsutula* are hardly more strictly used. My impression is that these "species" hybridize here naturally and freely. With this explanation, specimens are assigned to *N. exaltata* as follows: Raivavae, no. 15862; Rurutu, no. 16574; Rapa, nos. 11565, 15439; Marotiri, no. 15686; Mangareva, no. 11356.

Pantropic.

N. hirsutula (Forster) Presl.

Borabora, no. 12165; Tahaa, nos. 12145, 17393; Meetia, nos. 14194, 14241; Rapa, no. 15248; Pitcairn, no. 11267.

Pantropic.

N. Duffii Moore.

Rurutu, in culture, no. 11905.

The comparatively well defined cosmopolitan species, *N. cordifolia*, has not been found east of Tahiti.

Sphenomeris chusana (Linnaeus) Copeland.

Tahaa, no. 17349; Rurutu, nos. 16667, 16779; Raivavae, nos. 16174, 16177.

Westward to Madagascar, and to Japan.

Lindsaya decomposita Willdenow.

Tahiti, no. 17029.

Marquesas to India; not known in southeastern Polynesia.

L. propinqua Hooker, variety **simplicior** J. W. Moore.

Raiatea, type locality, no. 17282.

Named following Moore.

Lindsaya eximia Copeland, new species (pl. 17).

Rhizomate repente, 2 mm crasso, paleis fuscis 1 mm longis persistentibus vestito; stipitibus proximis, 30 cm altis sulcatis, fuscis; fronde 30 cm alta, bipinnata, parte mediale elongata, pinnis pinnatis 2-6; pinnulis 3-3.5 cm longis, 1 cm latis, dimidiatis, apice obtusis vel rotundatis rarius subacutis, latere acroscopico leviter incisis, lobis brevibus latis fertilibus truncatis, venis anasto-

mosantibus series plerumque II areolarum includentibus; soris 4-7 pinnulae quaeque, elongatis, indusio angusto cum margine conterminante.

Society Islands: Huahine, Mount Matoereere, north ridge in woods, altitude 650 meters, October 1, 1934, St. John no. 17158.

Related to *L. propinqua* Hooker, which Moore restores as distinct from *L. decomposita*. *L. eximia* is conspicuously larger and coarser.

Hypolepis punctata (Forster) Bernhardi.

Rurutu, no. 16668; Tubuai, no. 16342; Raivavae, no. 16171; Rapa, nos. 11617, 15300; Mangareva, nos. 14893, 14899.

New Zealand to China.

Histiopteris incisa (Thunberg) J. S. Smith.

Tahiti, no. 17066; Tubuai, no. 16326; Raivavae, no. 16175; Rapa, nos. 11435, 11446, 11474, 11580.

Pantropic and southern.

Pteris decussata J. Smith.

Tahiti, no. 17106.

Westward to Sumatra.

P. tremula R. Brown.

Raivavae, saddle between Mount Turivao and Mount Muatapu, altitude 180 meters, no. 11778. Quadripinnatifid at base; sterile distal part of segments sharply serrate; indusium crisped.

Common in New Zealand and in New Caledonia; reported in Tahiti.

P. tripartita Swartz.

Raiatea, no. 17331; Rurutu, no. 16664; Tubuai, no. 16464; Rapa, no. 15718.

Westward to Africa.

P. comans Forster.

Raivavae, nos. 11781, 16026; Rapa, nos. 15253, 15256.

Marquesas to New Zealand and Tasmania.

Acrostichum aureum Linnaeus.

Borabora, no. 17413; Rimatara, no. 16819; Tubuai, no. 16253; Rapa, no. 11400.

Cheilanthes tenuifolia (Burmann) Swartz.

Rapa, no. 15581; Marotiri, no. 15676.

New Zealand to India.

C. Arnottiana J. W. Moore.

Raivavae, nos. 11774, 11796.

Society Islands, and probably westward (*Notholaena hirsuta*) to China.

Doryopteris concolor (Langsdorff and Fischer) Kuhn.

Raivavae, nos. 11768, 15969.

Pantropic.

Adiantum Capillus-Veneris Linnaeus.

Rurutu, no. 16718; Mangareva, no. 11108.

Cosmopolitan.

A. hispidulum Swartz.

Rurutu, no. 16772; Tubuai, no. 16534; Pitcairn, no. 15031—these three almost typically setose; Raivavae, no. 15851; Mangareva, nos. 14452, 14520; Agakauitai, no. 14941—these four more glabrous, but still setose on surfaces and indusium.

New Zealand and Hawaii to Africa.

Adiantum glabrum Copeland, new species (pl. 18).

A. hispidulo Swartz simile, axibus hinc illunc minute pubescentibus haud setiferis, lamina utraque facie aut glabra aut pilis minutis debilibus sparsissimis subglabra, indusio omnino glabro distinctum.

Rapa: Toutore, west end of Mount Vaitau, on moist mossy rocks, in moist forest, altitude 240 meters, St. John and Maireau no. 15418, type; Motenaonao Point, 10 meters within cave, on damp loam, altitude 10 meters, St. John and Maireau no. 15495; moist ravine on southeast side of Mount Ororangi, altitude 200 meters, Fosberg no. 11410; the preceding three collections have the lamina glabrous. The following two collections have a few hairs on the nether surface, but none on the indusium; south slope of ridge between Mount Morongota and Mount Vaitau, in moist forest, altitude 150 meters, Fosberg no. 11606; watering place near Area, under trees by stream, altitude 5 meters, St. John and Fosberg no. 15231.

Brown and Brown (Bishop Museum Bull. no. 89, p. 77) have listed under *A. hispidulum* several other Rapa collections which they describe as glabrate. The indusium, at least, is glabrous in distinction to glabrate.

A. hispidulum, from Africa to Polynesia and New Zealand, is a

satisfactorily uniform species, and I am unwilling to refer to it so distinct a local derivative as this of Rapa. It may be noted that Tahitian specimens of *A. hispidulum* are less hispid than those of other lands —at least this is so of the eleven collections in hand; but the indusium is invariably distinctly bristly when young. The Society Islands are the ascribed source of *A. pubescens* Schkuhr (Krypt. Gew. 108, pl. 116), regarded as synonymous with *A. hispidulum* which Swartz ascribed to New Holland. Schkuhr's plate shows hairy lamina but naked indusium—probably in error.

Oleandra Sibbaldii Greville.

Tahiti, no. 17025.

Westward to the Philippines.

Humata Banksii Alston (*H. pectinata* of Bull. 93, not Desvaux).

Tahaa, nos. 12142, 17373; Raiatea, nos. 17243, 17323, 17327; Rurutu, nos. 16662, 16752, 16767.

The material is not in hand for a geographic delimitation of this species and *H. pectinata* (Smith) Desvaux.

H. huahinensis Copeland.

Huahine, no. 17200.

Endemic.

H. Andersonii Mettenius.

Tahiti, no. 17150.

Endemic.

Davallia—probably **D. epiphylla** (Forster) Sprengel.

Meetia, no. 14181, sterile.

Polynesia—at least Rarotonga.

D. solida (Forster) Swartz.

Tahiti, no. 14137; Raiatea, no. 17231; Borabora, no. 12163; Tahaa, nos. 12146, 17371; Rimatara, no. 16945; Rurutu, no. 16586; Tubuai, no. 16210; Raivavae, nos. 15809, 15859, 16101; Rapa, nos. 11409, 11450, 11609, 15369; Mangareva, nos. 14465, 14935; Akamaru, no. 14679; Aukena, no. 14607; Taravai, no. 14791; Pitcairn, nos. 11270, 15048; Henderson, no. 15108.

Westward to Burma. All Rapa specimens are notably dissected, approaching *D. fejeensis* Hooker.

Hymenolepis revoluta Blume.

Tahiti, nos. 14146, 17102.

New Caledonia to Annam.

H. mucronata Fée.

Raivavae, nos. 15985, 15990, 16044; Tubuai, nos. 16348, 16512,—the last, a stunted specimen, with the aspect of the next species, *H. minor,* but with far less spiny paleae.

Hymenolepis minor Copeland, new species (pl. 19).

Rhizomate 4 mm crasso, paleis atrocastaneis 3.5 mm longis, basi dilatata exsculpta 1.5 mm latis deinde angustatis caudatis margine conspicue et dense spiniferis parietibus cellularum validis immerso; stipitibus approximatis, 1-1.5 cm longis, gracilibus, brunneis; frondis parte sterile ca. 10 cm longa, 15 mm lata, deorsum attenuata, infra apicem fertilem ad 2 mm contracta, glabra, coriacea, venis inconspicuis, costa inferne prominente; parte fertile 2-4 cm longa, 3-4 mm lata, plerumque recurva, sporangiis cum paraphysibus parvis deciduis immixtis.

Austral Islands: Raivavae, south side of Mount Turivao, rock crevices in cliff, altitude 200 meters, August 11, 1934, Fosberg no. 11783, type; also, St. John and Fosberg no. 15807, in shade, with stipes up to 3 cm and sterile part of fronds up to 20 cm long, hardly at all coriaceous, with short fertile segments.

The paleae are the most spiny-ciliate known to me in the genus.

Hymenolepis dura Copeland, new species (pl. 20).

Rhizomate repente, 1 cm crasso paleis membranaceis 5 mm longis basi fere 2 mm latis deinde valde attenuatis margine spinulosis, parietibus cellularum magnarum tenuibus uniformibus immerso; stipitibus 1 cm inter se distantibus, 2 cm longis, fuscis; frondis parte sterile 10-15 cm longa, 2 cm lata, deorsum attenuata, infra apicem fertilem haud constricta, glabra, brunnescente, rigidissima, venis omnino occultis et costa vix conspicua; apice fertile usque ad 4 cm longa et 1 cm lata (plerumque minore), ubique dense fructifera, sporangiis primo paraphysibus peltatis clathratis spinoso-ciliatis obtectis, demum eisque immixtis.

Rapa: south side of Mount Lekie, ledges of highest basalt precipice, altitude 330 meters, July 20, 1934, St. John and Maireau no. 15621.

Of previously known species, the most similar is *H. Vaupelii* C. Christensen of Samoa, which has the mass of sporangia similarly protected while young, by peltate paraphyses.

Cyclophorus macrocarpus (Hooker and Arnott) Copeland.

Raivavae, nos. 15796, 15828, 16056, 16109; Rapa; Mangareva, no. 14845; Pitcairn, no. 14962.

Rarotonga, Tahiti.

This is not *C. angustatus* (Swartz) Desvaux. I have already noted (Bishop Museum Bull. 93, p. 60, 1932) that it is nearer to *C. blepharolepis*. With the accumulation of many specimens, I find it hardly possible to distinguish these two. However, it is not worth while to reduce the latter species until a check of Forster's type of *C. acrostichoides* may show that that is not the correct name of both.

C. blepharolepis C. Christensen.

Tahiti, no. 14148; Huahine, no. 17182; Meetia, no. 14237; Rimatara, no. 16848; Rurutu, no. 16556; Tubuai, no. 16505; Rapa, no. 15345; Mangareva, nos. 14453, 144455; Taravai, no. 14781; Henderson, nos. 15147, 15154. Fiji.

Elaphoglossum Societarum Copeland.

Huahine, no. 17163.

Endemic in the Society Islands.

E. samoense Brackenridge.

Tahiti, nos. 16992, 17028, 17051, 17069 (?); Rapa, nos. 11385, 11563, 15438.

Samoa.

Elaphoglossum rapense Copeland, new species (pl. 21).

Rhizomate breve, valido, adscendente; stipitibus caespitosis 15-18 cm longis, basi paleis castaneis linearibus aciculatis, sursum paleis paullo minoribus ferrugineis, omnibus minute ciliatis dense vestito; fronde usque ad 30 cm longa, 7 cm lata, acuta, basi rotundata vel late cuneata, papyracea, margine et costa densissime faciebus tantum sparsius paleis lineari-aciculatis ferrugineis minute ciliatis vestita; venis liberis; fronde fertile ca. 13 cm longa, 2.5-3.5 cm lata.

Rapa: Kaimaru, south ridge of Mount Perahu, on ground or fallen logs in rain forest, altitude 475 meters, St. John and Maireau no. 15529, type; also, Taratika, east side of Mount Perahu, altitude 620 meters, St. John, Fosberg and Maireau no. 15644.

One of the group of *E. hirtum,* but distinct from that species, from its variety *nitens,* and from *E. tovii* Brown, in having the paleae minutely ciliate.

E. gorgoneum (Kaulfuss) Brackenridge.

Tahiti, no. 17048; Huahine, no. 17160; Raiatea, no. 17270.

Hawaii, Rarotonga.

Polypodium blechnoides (Greville) Hooker.

Raiatea, no. 17284, from the type locality of *P. minutissimum* J. W. Moore; Huahine, no. 17167.

Westward across Malaya.

Prosaptia contigua (Forster) Presl.

Tahiti, nos. 17026, 17117, 17429; Tahaa, no. 17387.

Very broadly construed, this ranges from the Marquesas to Ceylon.

Grammitis subspathulata (Brackenridge) Farwell.

Tahiti, nos. 17122, 17149.

Endemic.

Grammitis Maireaui Copeland, new species (pl. 22).

Rhizomate repente, cum paleis 5 mm crasso, paleis fuscis 3 mm longis, 1 mm latis, obtusis integris immerso; stipitibus approximatis 3-5 cm longis, setis atropurpureo-fuscis horizontalibus 1 mm longis dense vestitis; fronde usque ad 20 cm longa et 16 mm lata, utrinque angustata, integra vel rarius minute crispata, costa et margine minutius setiferis, firme papyracea, translucente, venis 3-4-furcatis, soris ad ramos infimos acroscopicos dorsalibus, subcostalibus, superficialibus orbicularibus sed receptaculis elongatis, sporangiis setiferis.

Rapa: Taratika, east side of Mount Perahu, on mossy trunk in rain forest, altitude 550 meters, July 15, 1934, St. John and Maireau no. 15553.

A relative of *Grammitis subspathulata* of Tahiti, distinguished by having superficial sori nearer to the midrib than to the margin; also, the paleae are darker, and the fronds thinner and broader.

Grammitis miltiblepharis Copeland, new species (pl. 23).

Rhizomate breve adscendente, paleis laete ferrugineis 2 mm longis basi 1 mm latis acutis integris membranaceis vestito; stipitibus caespitosis; aut usque ad 8 mm longis aut ob laminam decurrentem subnullis, setis vix 1 mm longis haud dense vestitis; lamina 4-5 mm longa, 3-3.5 mm lata, lineari-oblanceolata, obtusa subcoriacea, superficie sparsius costa et margine dense setis 0.3-0.4 mm longis rubido-castaneis vetustate fuscescentibus vestita; venis sterilibus plerisque simplicibus, intra marginem liberis, fertilibus furcatis; soris prope bases ramorom acroscopicorum fere costalibus, vix elongatis, sporangiis setiferis.

Marquesas: Nukuhiva, Ooumu, altitude 1100 meters, "epiphytic on mossy branches in damp forest", Mumford and Adamson no. 586 (mixed with *G. marginelloides*).

This is likely to be *Polypodium Hookeri* variety *rapense* E. Brown (Bishop Museum Bull. 89, p. 86, 1931). I do not take up the varietal name, because it would be inappropriate for a plant described from Nukuhiva, and because I am not sure of the identity. It differs from *Grammitis conformis* (Brackenridge) J. Smith as described, in smaller size and in bearing hairs on the surfaces; and from *Polypodium Hookeri,* in smaller size, thinner texture, and much shorter hairs. As a specific name, *G. conformis* has place priority over *P. Hookeri,* but Baker combined them under the latter name.

It seems best to describe this plant here, though it is of an earlier collection.

G. trachycarpa (Mettenius) Copeland, new combination.

Polypodium trachycarpum Mettenius: Linnaea, vol. 36, p. 127, 1869.

Huahine, no. 17166.

Endemic in the Society Islands.

G. raiateensis (J. W. Moore) Copeland, new combination.

Polypodium raiateense J. W. Moore: Bishop Museum Bull. 102, p. 10, 1933.

Raiatea, no. 17287.

Local.

G. marginelloides (J. W. Moore) Copeland, new combination.

Polypodium marginelloides J. W. Moore: Bishop Museum Bull. 102, p. 10, 1903.

Raiatea, no. 17292. Nukuhiva, Mumford and Adamson, no. 586 pro parte.

Calymmodon orientalis Copeland.

Tahiti, nos. 17060, 17070, the latter suggesting *C. Grantii.*

Endemic.

Calymmodon rapensis Copeland, new species (pl. 24).

Caudice breve erecto, apice paleis laete brunneis lanceolatis 3 mm longis acuminatis aut aristatis immerso; fronde sessile, usque ad 10 (saepius 6) cm longa, parte sterile 4, fertile 5 mm lata, ad alam costae pinnatifida, costa praecipue inferne pubescente, segmentis sterilibus 2 mm latis basibus contiguis, sparsissime ciliatis, fertilibus conduplicatis et ideo triangularibus.

Rapa: Taratika, east side of Mount Perahu, on mossy trunks on main ridge, altitude 620 meters, St. John, Fosberg and Maireau no. 15666, July 21, 1934, type; ibidem, altitude 550 meters, St. John and Maireau no. 15555.

Distinguished by the slender but not very lax fronds, with the costa much more hairy than the margin, and the large paleae. Of the two Tahitian species, this is like *C. orientalis* in its paleae, more like *C. Grantii* in compactness and different from both in pubescence.

Loxogramme Parksii Copeland.

Tahiti, nos. 17092, 17116; Rapa, nos. 15554, 15641.

Fiji. The fronds of Tahiti specimens are characteristically narrower than most of those from Fiji. Those of Rapa have short and stout, or obsolete stipes. It is only from Fiji that we have any wealth of collections; and as these vary considerably, it is inexpedient to undertake to distinguish the few collections from Tahiti and Rapa.

Microsorium punctatum (Linnaeus) Copeland.

Tahiti, no. 14149; Borabora, no. 17419.

Westward to Africa.

M. vitiense (Baker) Copeland, new combination.

Polypodium vitiense Baker: Journal of Botany, p. 298, 1879.

P. euryphyllum Brown: Bishop Museum Bull. 89, p. 90, not C. Christensen.

P. societense J. W. Moore: Bishop Museum Bull. 102, p. 9.

Rurutu, no. 16672; Tubuai, no. 16446. Raivavae, no. 15982; Rapa, nos. 15240, 15403; Mangareva, no. 14873; Pitcairn, nos. 11299, 11312, 14982.

Evidently common in woods at moderate altitudes, from Fiji to Pitcairn. I cannot recognize the geographic varieties named in Bulletin 89.

M. maximum (Brackenridge) Copeland, new combination.

Drynaria maxima Brackenridge: U. S. Expl. Exped., vol. 16, p. 51, pl. 7, 1854.

Tahaa, no. 17360; Huahine, no. 17205.

Endemic in the Society Islands.

M. Scolopendria (Burmann) Copeland.

Tahaa, no. 17354; Raiatea, no. 17226; Meetia, no. 14232; Rimatara, no. 16908; Rurutu, no. 11944; Tubuai, nos. 16252, 16383,

16406; Maria, nos. 12084, 12091, 12108, 16955; Raivavae, nos. 15836, 16128, 16146; Rapa, nos. 11447, 11531, 15548, 15607, 11626, 15302, 15360—the last three with narrow, undulate segments; Anaa, no. 14303; Hao, no. 14357; Tepoto, no. 14341; South Marutea, no. 14434; Mangareva, nos. 14457, 14906, (Makaroa) 14742, (Taravai) 14827, (Akamaru) 14687, (Tauna) 14751, (Aukena) 14645; Pitcairn, nos. 11260, 11305; Henderson, nos. 11347, 15095, 15139; 15125, 15138—these two quite abnormal, with broad segments, respectively simple fronds, and a tendency to produce main veins; Oeno, no. 15189; Flint, no. 17466; Timoe, no. 15204.

Westward across Africa.

M. nigrescens (Blume) Copeland, new combination.

Polypodium nigrescens Blume: Enumeratio, p. 126, 1828.

Tahiti, no. 17037; Tahaa, no. 17353.

Westward to India.

Microsorium pitcairnense Copeland, new species (pl. 25).

Phymatodes, rhizomate ad terram repente, 5 mm crasso, paleis atrocastaneis 4 mm longis acuminatis basi dilatatis 1.5 mm latis persistentibus vestito; phyllopodio 5 mm alto; stipite 30 cm alto, castaneo; fronde 30 cm alta et lata, ad alam costae 5 mm latam pinnatifida, basi brevi-decurrente; segmentis ca. 7-paribus, 17 cm longis, 17 mm latis, acuminatis, margine undulatis, viridibus, tenuiter papyraceis, venis dissolutis, areolas magnas 2-3-seriatis venulis recurrentibus et hamatis et ramosis efficientibus; soris utroque latere 2-3 mm intra marginem seriatis, 1 mm latis, valde immersis et e facie superiore praestantibus.

Pitcairn: Outer Valley on steep wooded slope, altitude 200 meters, June 14, 1934, Fosberg and Clark no. 11311.

A relative of *M. nigrescens* (Blume), from which it differs in the absence of distinct major areolae and in the relatively marginal sori. It must be more like *Polypodium Lenormandi* Baker, of New Caledonia, which I have not seen; but that species is described as pinnate with many pinnae.

I do not know whether *Microsorium* or *Phymatodes* is more likely to be regarded as the proper genus of this fern. It is, of course, a *Polypodium* in the usage of the past, but that usage has already endured too long.

Selliguea feeioides Copeland.

Tahiti, nos. 17027, 17247.

Westward to the New Hebrides.

Campium lonchophorum (Kunze) Copeland.

Tahiti, no. 14130; Rurutu, nos. 16654, 16768; Rapa, nos. 11471, 15331.

Westward to Queensland.

Antrophyum reticulatum (Forster) Kaulfuss.

Tahiti, no. 17337.

Westward to India.

A. plantagineum (Cavanilles) Kaulfuss.

Tahaa, no. 17337; Meetia, no. 14248; Tubuai, no. 16448; Raivavae, no. 16048.

Westward to India.

Vittaria elongata Swartz.

Tahiti, no. 14132; Tahaa, no. 17392; Tubuai, no. 16352; Rurutu, nos. 16728, 16770; Raivavae, nos. 11730, 11735, 11788, 15938; Rapa, no. 15413 and no number (Zimmerman); Pitcairn, nos. 11309, 14956.

Westward to Madagascar, in the broad sense in which the species is here construed.

Vaginularia paradoxa (Fée) Mettenius.

Tahiti, no. 17059.

Westward to Ceylon.

LYCOPODINEAE

PSILOTACEAE

Psilotum complanatum Swartz.

Raiatea, no. 17302; Tahaa, no. 17391.

Pantropic.

P. nudum (Linnaeus) Grisebach.

Borabora, no. 17422; Huahine, no. 17186; Meetia, no. 14196; Rimatara, no. 16869; Tubuai, no. 16517; Maria, nos. 12110, 16966; Raivavae, no. 15983; Rapa, nos. 15238, 15635; Anaa, no. 14289; South Marutea, no. 14448; Hao, no. 14382; Mangareva, nos. 14472, (Aukena) 14599; (Akamaru) 14678, (Agakauitai) 14937; Pitcairn, nos. 11225, 11269, 11318; Flint, no. 17475.

Pantropic.

Tmesipteris tannensis Bernhardi.
Tahiti, no. 17055.
Marquesas and New Zealand to the Philippines.

LYCOPODIACEAE

Lycopodium serratum Thunberg.
Tahiti, Orofena, south ridge, on mossy branch in upper forest, altitude 1,700 meters, St. John and Fosberg no. 17008.
Almost cosmopolitan; new to Tahiti.

L. squarrosum Forster.
Tahaa, no. 17386; Tahiti, no. 14165; Tubuai, no. 11810; Rapa, nos. 15400, 15617, and 15735.
Westward to India.

L. Haeckelii Herter.
Tahiti, no. 17079.
Endemic.

L. cernuum Linnaeus.
Tahiti, no. 17148; Tahaa, no. 17335; Huahine, no. 17193; Rurutu, no. 16679; Tubuai, no. 16339; Raivavae, no. 16027; Rapa, nos. 11393, 11476, and 11536; Mangareva, no. 11115.
Pantropic.

L. venustulum Gaudichaud.
Rapa, no. 15571.
Tahiti, Hawaii.

L. volubile Forster.
Tahiti, no. 16993.
New Zealand to Sumatra.

L. Phlegmaria Linnaeus.
Tahiti, no. 14154; Tubuai, no. 16330.
Westward to Africa.

L. phlegmarioides Gaudichaud (?).
Tubuai, no. 16498; Raivavae, no. 16161.
Polynesia, Rawak.

L. Ribourtii Herter.
Tahiti, no. 17043.
Rarotonga.

PLATE 1.—*Angiopteris chauliodonta* Copeland.

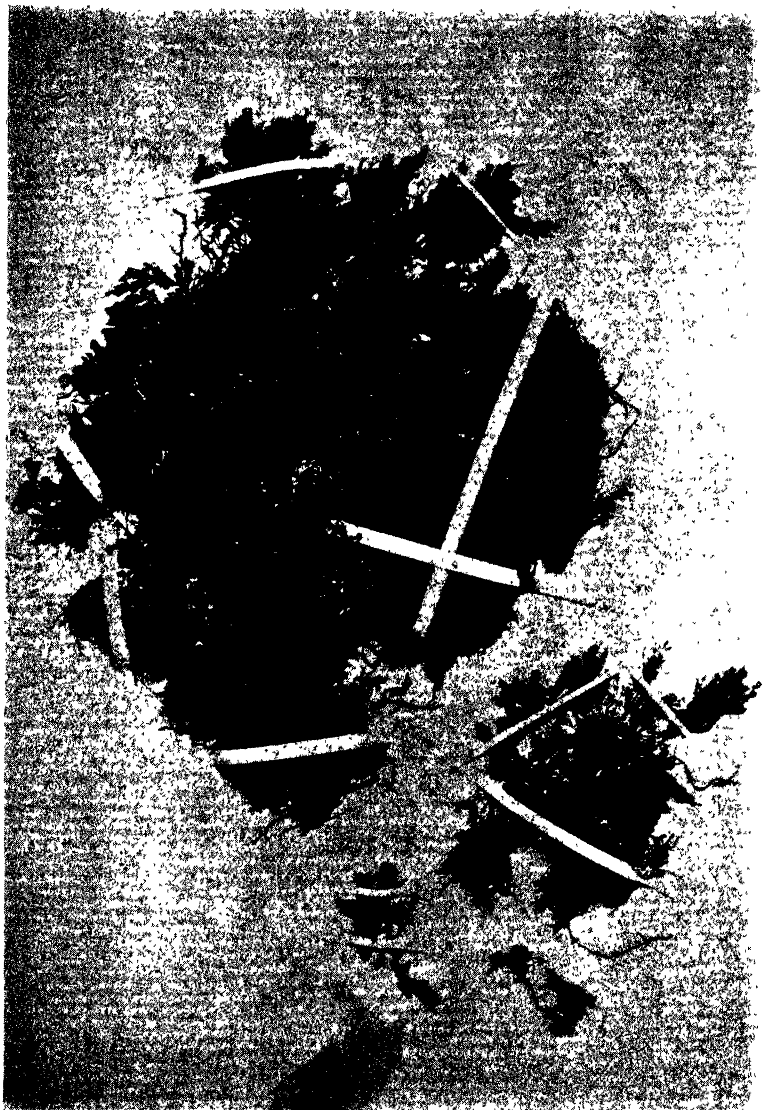

PLATE 2.—*Mecodium diversilabium* Copeland.

PLATE 3—*Callistopteris calyculata* Copeland

PLATE 4.—*Macroglena truncata* Copeland.

PLATE 5.—*Cyathea rapensis* Copeland

PLATE 6.—*Dryopteris diversisora* Copeland

PLATE 7.—*Dryopteris rurutensis* Copeland.

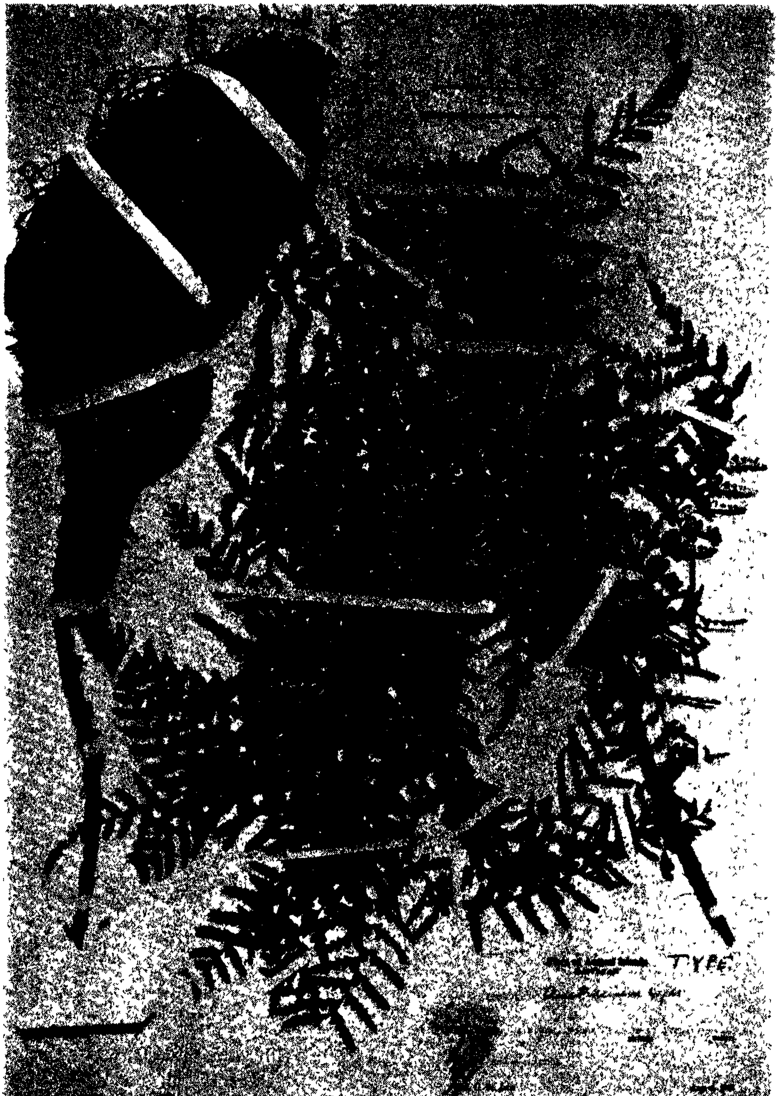

PLATE 8.—*Polystichum Australium* Copeland.

Plate 9—*Polystichum paleatum* Copeland

PLATE 10.—*Athyrium Sancti-Johannis* Copeland.

PLATE 11.—*Athyrium pitcairnense* Copeland.

Plate 12.—*Athyrium tenuipaleatum* Copeland

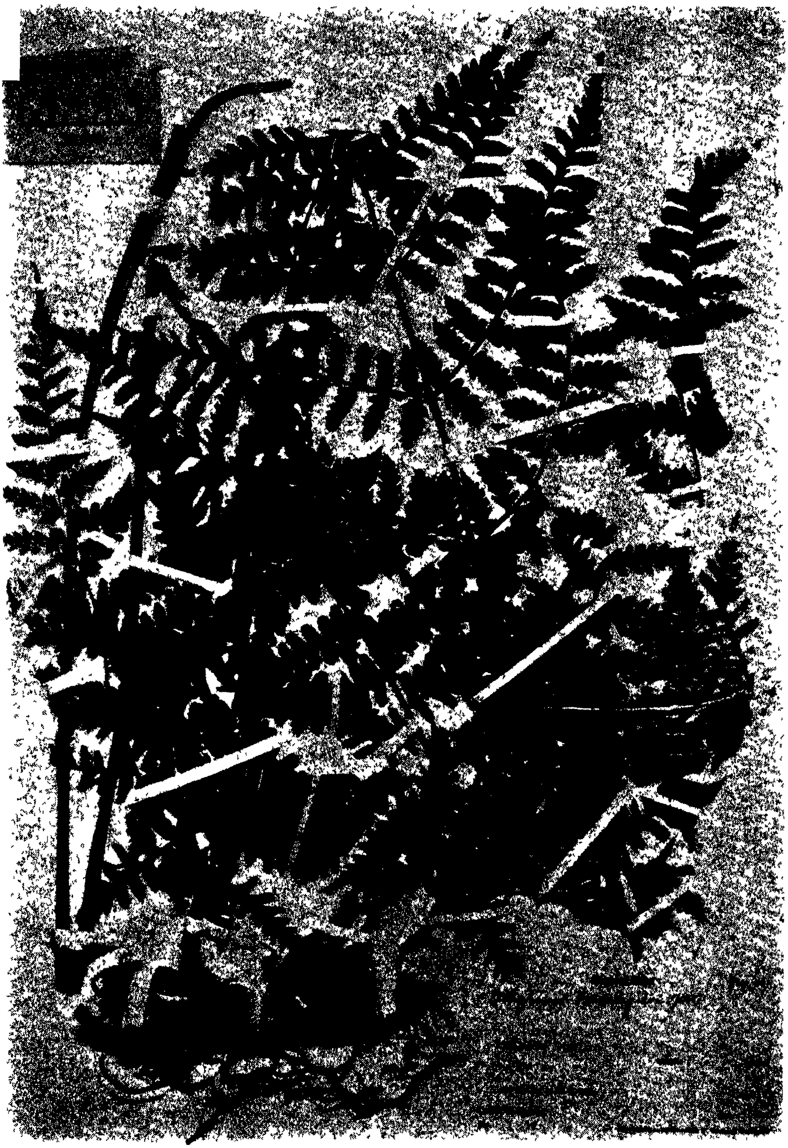

PLATE 13.—*Athyrium Fosbergii* Copeland.

PLATE 14.—*Athyrium subquadripinnatum* Copeland.

PLATE 15.—*Blechnum venosum* Copeland.

PLATE 16.—*Asplenium indusiatum* Copeland.

PLATE 17.—*Lindsaya eximia* Copeland.

PLATE 18.—*Adiantum glabrum* Copeland.

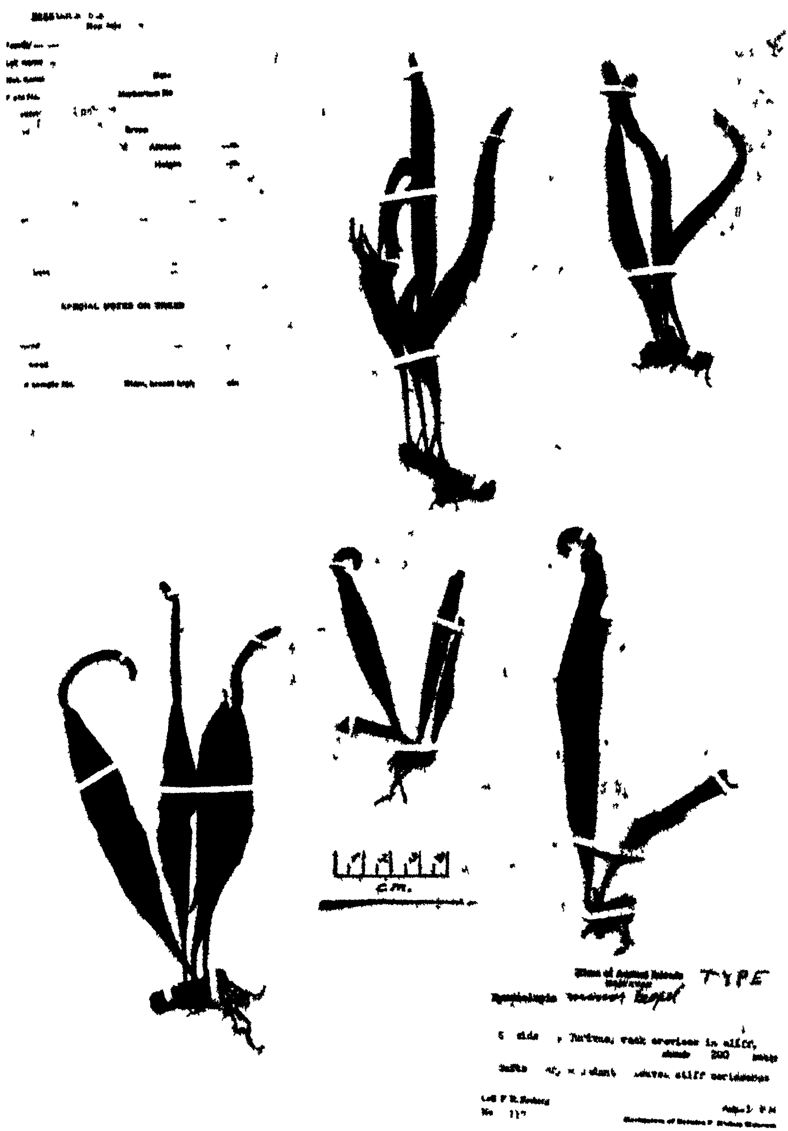

PLATE 19—*Hymenolepis minor* Copeland

PLATE 20.—*Hymenolepis dura* Copeland.

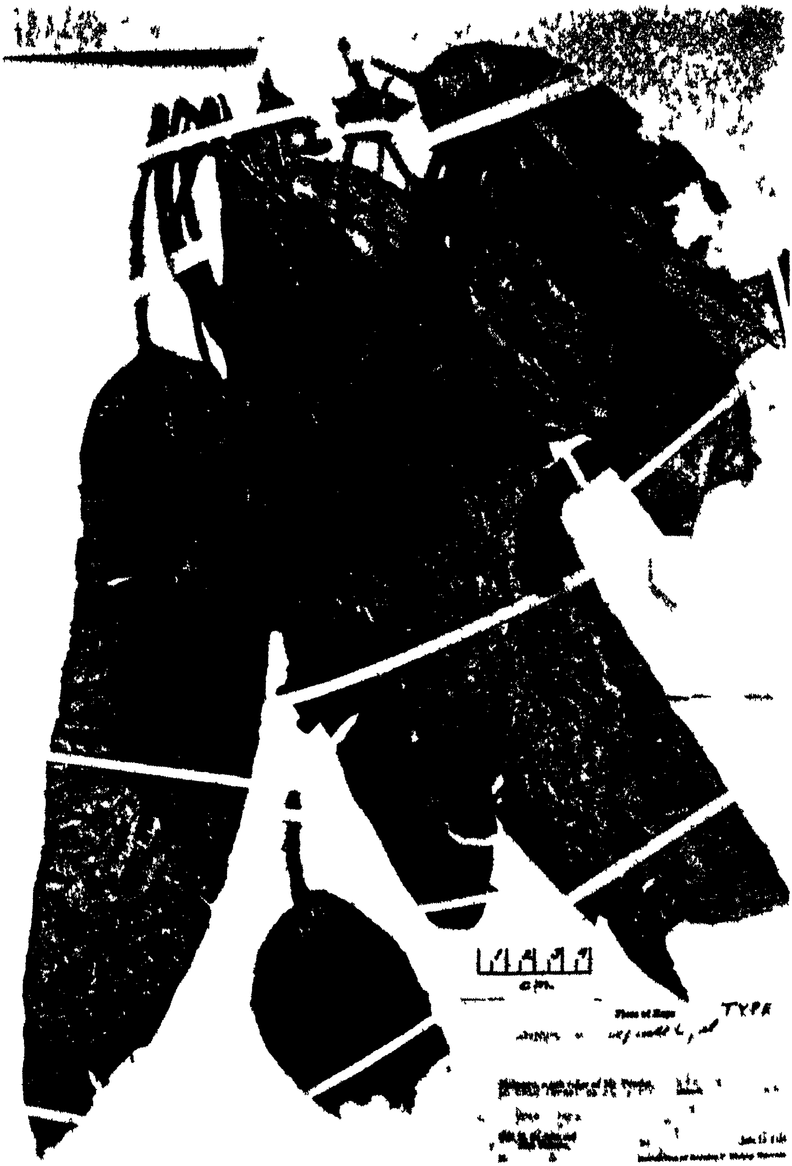

PLATE 21.—*Elaphoglossum rapense* Copeland

PLATE 22.—*Grammitis Maireaui* Copeland.

PLATE 23—*Grammitis multiblepharis* Copeland

PLATE 24.—*Calymmodon rapensis* Copeland.

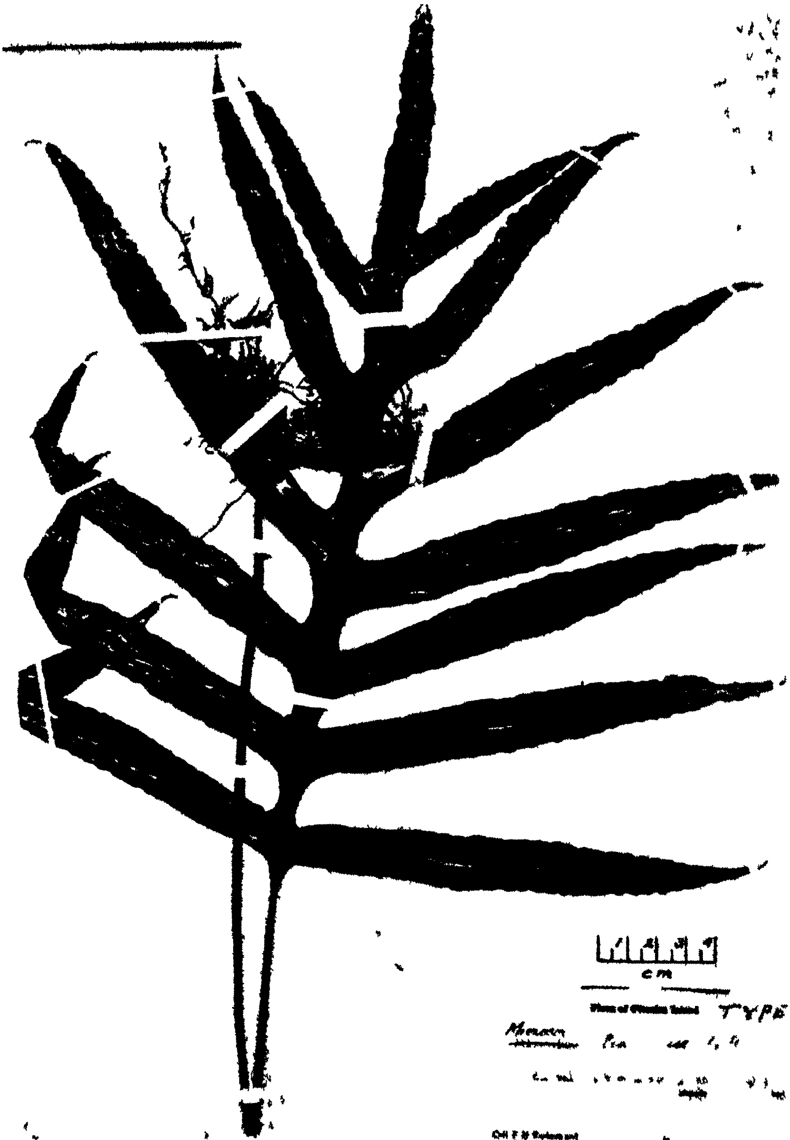

PLATE 25.—*Microsorium pitcairnense* Copeland

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM

Volume XIV | June 4, 1938 | Number 6

Carabidae of the Society Islands and Rapa (Coleoptera)[1]

By EVERARD B. BRITTON
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INTRODUCTION

This paper is a report on the Carabidae collected by the Mangarevan Expedition in southeastern Polynesia in 1934. It deals with species from the Society Islands and a few from Rapa. The collection includes 60 individuals comprising 12 species, of which four species from high altitudes in Tahiti are new and are described below. The types of the new species are stored in Bishop Museum; paratypes are in the British Museum. In order to make this report as complete as possible, I include hitherto unpublished records of Carabidae collected on the islands of Tahiti and Rapa by C. L. Collenette and Miss L. E. Cheesman of the St. George Expedition in 1925.

Very little has been written on the Carabidae of the Society Islands. Leon Fairmaire in his "Essai sur les Coléoptères de la Polynésie" (Rev. Mag. Zool., pp. 43, 277, 1849) recorded nine species from Tahiti, six of which were described by C. H. Boheman (Eugenies Resa, p. 16, 1858), and two by J. Redtenbacher (Reise Novara, III, p. 19, 1867).

I wish to express my thanks to Monsieur René Oberthur for his kindness to me during a visit to Rennes, where I was able to examine the types of species described by Fairmaire, to Dr. O. Lundblad and Dr. P. A. Roman of the Stockholm Museum for the loan of the three types of Boheman, and to Dr. K. Holdhaus of Vienna for the loan of the types of the two species described by Redtenbacher.

[1] Mangarevan Expedition Publication 23.

FAMILY CARABIDAE

SUBFAMILY HARPALINAE

TRIBE BEMBIDIINI

Tachys sexguttatus Fairmaire, 1849.

Tachys quadrillum Schaum, 1860, new synonym.

Tahiti: Papeete, Blue Lagoon, taken at light on seashore, March 1, 1934, one example collected by E. C. Zimmerman.

Since the example agrees exactly with the description given by Fairmaire, and was obtained at the type locality, I have no hesitation in referring it to the above species. I have, however, been unable to verify this identification by comparison with the type, as I did not succeed in finding this in the collections of Monsieur René Oberthur at Rennes or at the Musée d'Histoire Naturelle, Paris, although at Rennes I saw examples of the original series of other species described by Fairmaire in the same paper. The example also proves to be identical with *Tachys quadrillum* Schaum, a species widely distributed from India to New Guinea and Samoa. I have, therefore, established the synonymy.

TRIBE NOMIINI

Thriscothorax altiusculus, new species (figs. 1, *a*; 2, *a*).

Length, 5.75-6.3 mm. *Color,* piceous to black, slightly aeneous; antennae, mandibles, palpi, tarsi, and margins of prothorax and elytra rufo-testaceous; first interval of elytra sometimes paler than the remainder; legs brown, paler at knees; ventral surface reddish brown. *Head,* with a groove on each side, limited by a ridge laterally, running back from the clypeus to a point between the supraorbital setae. *Prothorax,* length 1.26-1.5 mm.; greatest width (middle) 1.51-1.96 mm.; width across apex 1.05-1.96 mm.; width across base 0.98-1.19 mm.; sides without sinuation near base; smooth; convex; punctured across the base; side margins wide (approximately 0.1 mm.) and sharply reflexed; one seta on each side at the widest point; posterior angles completely rounded and without setigerous punctures; median line very faint. *Elytra,* length 3.6-4.2 mm.; greatest width 2.45-2.87 mm.; oval, moderately convex; margins strongly reflexed; striae clearly impressed and feebly punctured in the anterior third; intervals flat, the third with two setigerous punctures; seventh stria faint except at apex; scutellar striole with four punctures. Hind wings vestigial.

Tahiti: Mount Aorai Trail, 4,500-6,000 feet, Sept. 14, 15, 1934, seven examples collected on *Freycinetia* by E. C. Zimmerman.

Thriscothorax constrictus, new species (figs. 1, *b*; 2, *b*).

Length, 3.85 mm. (type). *Color,* piceous to black; slightly aeneous, shin-

ing, mandibles, palpi, antennae, and legs testaceous, ventral surface reddish brown. *Head*: eyes small and not as prominent as in most species. *Prothorax*, length 0.83 mm., greatest width (at one third of length from apex) 1.08 mm., width across apex 0.73 mm., width of base 0.65 mm., cordate, posterior angles rectangular, disc convex, margins very narrow, reflexed, base depressed, with

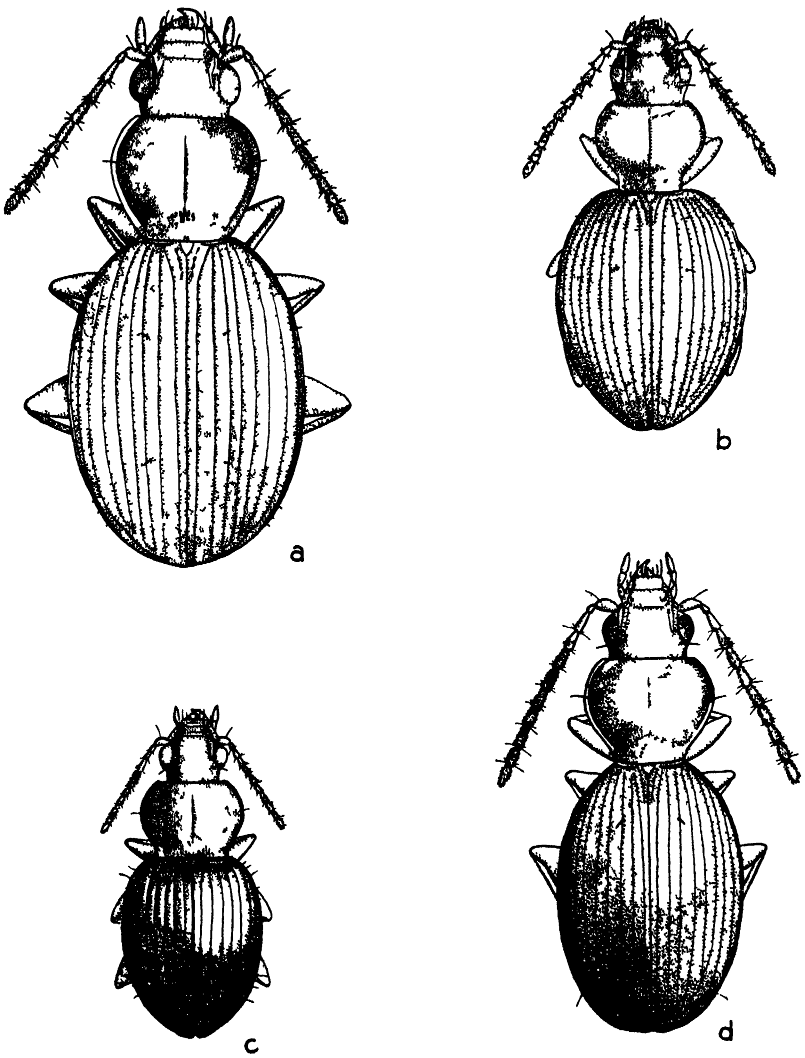

FIGURE 1.—New species of *Thriscothorax*: *a*, *T. altiusculus*; *b*, *T. constrictus*; *c*, *T. minutus*; *d*, *T. bryobius*.

a few large punctures; median line only slightly impressed. *Elytra,* length 2.35 mm.; median width 1.91 mm.; broadly oval and very convex; margins reflexed; striae clearly impressed, unpunctured; intervals slightly convex, the third intervals with a single puncture; stria 7 obvious throughout its length; hind wings vestigial.

Tahiti: Mount Aorai Trail, 3,500-4,500 feet, Sept. 13, 15, 1934, two examples taken by beating moss on trees and shrubs by E. C. Zimmerman.

Thriscothorax minutus, new species (fig. 1, *c*).

Length, 3.6 mm. (type). *Color,* head and prothorax aeneous-black; elytra aeneous-brown; mandibles, palpi, legs and antennae testaceous, the antennae becoming darker toward their apices; ventral surface reddish brown. *Head,* eyes moderately prominent; anterior supraorbital setae and punctures absent. *Prothorax,* length 0.8 mm.; greatest width 1.12 mm.; width at apex 0.72 mm.; width at base 0.79 mm.; cordate; posterior angles very slightly acute, almost rectangular; disc moderately convex; lateral margins very narrow, reflexed; base depressed, somewhat rugose, and with a few obsolete punctures; median line slightly impressed. *Elytra,* length 2.08 mm.; greatest width 2.24 mm.; broadly ovoid, moderately convex, falling off steeply at the sides from the sixth stria; margins narrow, reflexed; striae impressed, without punctures except for a few at the apex and base of stria 8; stria 7 obvious throughout its length; intervals flat, unpunctured; hind wings vestigial.

Tahiti: Mount Aorai Trail, 3,500 feet, Sept. 16, 1934, five examples taken on sand at edge of pond by E. C. Zimmerman.

Thriscothorax bryobius, new species (figs. 1, *d*; 2, *c*).

Length, 4.8 (type)–5.4 mm. *Color,* reddish brown to dark brown; head and prothorax usually darker than the elytra; margins of prothorax and elytra testaceous; mandibles, palpi, antennae, and legs testaceous; ventral surface reddish brown. *Prothorax,* length 1.08 (type)–1.26 mm.; greatest width 1.3 (type)–1.44 mm.; width at apex (type) 0.87 mm.; width at base (type) 0.68 mm.; cordate, with sides slightly sinuate near the base; posterior angles obtuse and rounded; lateral margins narrowly reflexed; surface moderately convex with the median line slightly impressed; base depressed, with only a few obsolete punctures. *Elytra,* length 3.06 mm.; greatest width 2.05 mm. (type measurements); oval, convex, margins narrowly reflexed; striae less deeply impressed than in the other species, with faint punctures spaced by three or four times their diameters; intervals flat; the third interval with two setigerous punctures placed approximately 0.7 mm. and 1.82 mm. from the base; stria 7 very faint and not set on a carina apically. The whole surface shows well defined microsculpture, formed of transverse spaces giving the elytra a matt surface, in contrast to the shining head and prothorax.

Tahiti: Mount Aorai Trail, 5,500-6,300 feet; Sept. 15, 1934, four examples taken by beating moss on trees and shrubs by E. C. Zimmerman.

Tribe HARPALINI

Selenophorus pyritosus Dejean, 1829.

Tahiti: Papeete, March 1925, six examples taken at light by St. George Expedition; April 1927, three examples collected by L. H. MacDaniels; Moara, Papeari, March 16, 1925, one example collected by G. P. Wilder; mouth of Fautaua Valley, March 13, 1934, two examples taken under boards by E. C. Zimmerman; Arihiri, Pare, March 1934, three examples taken by E. C. Zimmerman; Papeete, Blue Lagoon, March 1, April 8, 1934, ten examples taken at light by E. C. Zimmerman.

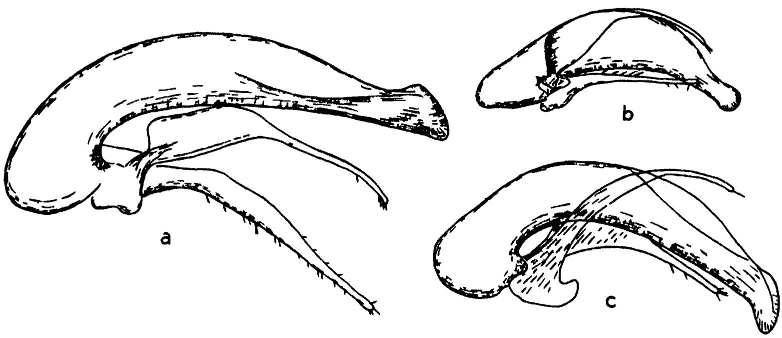

FIGURE 2.—Male genitalia of species of *Thriscothorax*: *a, T. altiusculus*; *b, T. constrictus*; *c, T. bryobius.*

Raiatea: 1926-27, five examples collected by J. W. Moore.

Tuamotu Islands: Makatea, 1932, one example collected by G. P. Wilder.

All the above examples differ from the typical Central American form in having the foveae of the fifth striae of the elytra somewhat smaller. As, however, this appears in a few examples from Central America, there is no justification for separating the island form. I am indebted to Dr. F. van Emden for pointing out this fact.

Acupalpus vestigialis Erichson.

Stenolophus dingo Castelnau.

Tahiti: Papeete, Blue Lagoon, Papeari, Tiupi Bay, March-May, 1934, six examples collected by E. C. Zimmerman; April 26, 1925, one example collected by L. E. Cheesman.

Distribution: Java, Mentawei Islands, New Guinea, Australia.

Tribe CHLAENIINI

Chlaenius flagiguttatus MacLeay var. **guttatus** Escholtz, 1829.

Tahiti: Apirimaue Valley near Tiupi Bay, Papeari, May 4, 1934, one example taken on sand by stream by E. C. Zimmerman.

Distribution: Philippine Islands, New Guinea, New Caledonia.

Tribe PERIGONINI

Perigona nigriceps Dejean, 1831.

Tahiti: Papara, Feb. 10, 1927, two examples collected by G. P. Wilder; Tiupi Bay, Papeari, April 28, 1934, one example taken beneath fallen coconuts by E. C. Zimmerman.

Distribution: cosmopolitan.

Tribe AGONINI

Agonum bothriophorus Redtenbacher, 1867.

Agonum (*Anchomenus*) *cooki* (Sloane), 1894, new synonym.

Rapa: April 11, 1925, two examples taken at light by C. L. Collenette.

Distribution: Tahiti; Queensland; Samoa.

Colpodes monticola (Fairmaire), 1849.

Anchomenus raptor Redtenbacher, 1867, new synonym.

Tahiti: Fautaua Valley, 2,500 feet, March 13, 1925, three examples taken at light by C. L. Collenette; May 1927, one example collected by L. H. MacDaniels; east slope of Mount Orofena, 4,500 feet, Sept. 22, 1934, two examples collected by F. R. Fosberg.

Raiatea: 1926-27, one example collected by J. W. Moore.

Rapa: April 11, 1925, one example taken at light by C. L. Collenette; northeast ridge of Mount Perahu, 1,300-1,700 feet, July 15, 1934, one example taken in dead *Cyathea* fronds by E. C. Zimmerman.

Distribution: previously known only from Tahiti.

I have seen the type of this species in the collection of Monsieur René Oberthur at Rennes. It is identical with the type of *Anchomenus raptor* Redtenbacher.

Colpodes anachoreta (Fairmaire), 1849.

Colpodes castaneus Boheman, 1858, new synonym.

Tahiti: east slope of Mount Orofena, 4,500 feet, Sept. 22, 1934, one immature example collected by F. R. Fosberg.

Distribution: known only from Tahiti.

The type of this species which I saw at Rennes is identical with that of *Colpodes castaneus* Boheman.

TRIBE LEBIINI

Endynomena pradieri (Fairmaire), 1849.

Tahiti: Papeari, Tiupi Bay, April 27, 1934, one example collected by E. C. Zimmerman.

Raiatea: 1926-27, one example collected by J. W. Moore.

Distribution: India, Ceylon, Cochin China, Tonkin, Sumatra, Philippine Islands, Cocos Islands, New Hebrides, Samoa, Ellice Islands, Marquesas, Hawaiian islands, Tonga Islands, Fiji islands.

The total number of species of Carabidae now known to occur in the Society Islands is 17. The remaining five species not recorded here are *Colpodes cremita* (Fairmaire), *Callida insularis* Boheman, *Lebia bembidioides* Fairmaire, *Lebia insularis* Boheman, *Plochionus pallens* Fabricius. I have examined the types of *Callida insularis* Boheman and *Lebia insularis* Boheman. Both of these species are undoubtedly natives of Central America. *Callida insularis* Boheman appears to be the same as *Callida sanguinicollis* Dejean, a species which occurs in Brazil, Colombia, Chiriqui (Panama), and Trinidad. New synonymy: *Callida sanguinicollis* Dejean, 1839
= *Callida insularis* Boheman, 1858.

According to Chaudoir (Soc. Nat. Mosc., Bull. **44**: 83, 1871), *Lebia insularis* Boheman is either a *Dianchomena* or a true *Lebia* of the *analis* group. Examination of the type shows that it belongs to the *Lebia* group, and from the pattern of the elytra and the parallel striation of the head it appears to be most closely allied to *Lebia rugifrons* Dejean. I have been unable to identify it with any known species from South or Central America, although it belongs to a small group of species restricted to the southern United States and Central America. I have been informed by Dr. Roman, of the Stockholm Museum, that several species described from material collected by the Eugenie Expedition and labeled "Taiti" have been found to be Brazilian. It is noteworthy that, although the types of *Lebia insularis* and *Callida insularis* are labeled "Taiti", the localities given in the original descriptions are "Insulae Taiti et Honolulu." Finally, if the types were actually taken on Tahiti, it is rather surprising that they

have not been obtained since. These facts cast a doubt on the truth of the locality given for these two species, and I therefore think it advisable to withdraw them from the list of Tahitian Carabidae.

Of the 15 species, to which the list has now been reduced, seven are at present known only from Tahiti; *Colpodes monticola* Fairmaire is found on the islands of Tahiti, Raiatea, and Rapa, while the remaining seven have evidently been introduced in relatively recent times. Of these, four have been introduced from the Oriental and Papuan regions, one from Central America, and two are cosmopolitan.

The 15 species can hardly be regarded as representative of the whole carabid fauna, so that few useful deductions can be made concerning the relationships of the fauna. Nevertheless the presence of species of *Thriscothorax* in Tahiti is of considerable interest as this genus is otherwise known only from the Hawaiian islands. The closely related *Mecyclothorax* is also known from the Hawaiian islands, while winged species occur in Australia. Since there are many species of these genera known from the Hawaiian islands, it seems probable that further collecting in the Society Islands will reveal many new forms there.

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV July 11, 1938 Number 7

Trypetidae of the Mangarevan Expedition[1] (Diptera)

By JOHN R. MALLOCH

This paper is based on the collection of Trypetidae made by the Mangarevan Expedition to southeastern Polynesia in 1934, and includes some additional data on two species collected by the late G. P. Wilder. Two genera are represented in the collection.

Genus DACUS Fabricius

Three of the four species of *Dacus* in the collection are described as new. With the exception of one species from the Society Islands, the collections are from islands from which the genus has been previously unrecorded.

The genus is widely distributed from Australia to China and Japan and throughout the Malayan region, in southern Asia and Africa, with one species occurring in southern Europe. It is unrepresented in the New World at present, but some of the species may be introduced there in commerce as the larvae are apparently invariably found in various fruits.

It appears unnecessary to present a key to the species, but exceptional features useful for recognition are noted under each new species. Keys to the species occurring in the Pacific islands have been published by Bezzi[2] and by me[3].

The species now before me may be referred to the subgenus *Chaetodacus* Bezzi, but there is more variation in the chaetotaxy of the thorax in *Dacus incertus* than is usual. If we accept the presence of the supra-alar bristle as indicative of subgeneric status here, it

[1] Mangarevan Expedition Publication 24.
[2] Diptera, Brachycera and Athericera of the Fiji islands, p. 100, 1928.
[3] Insects of Samoa . . . , pt. 6, fasc. 7, p. 254, 1931.

will be difficult to determine the position of specimens with that bristle present on one side and absent on the other, and of specimens in which the bristle is lacking on both sides. The exceptional feature of setulae on the upper side of the second section of the fifth wing vein can not be utilized for subgeneric segregation, as there is great variation in the number of bristles present, *D. incertus* usually lacking them.

Dacus setinervis, n. sp.

This is the only species of the genus known to me, or described, in which there are always setulose hairs on the upper side of the second section of the fifth wing vein.

Head orange-yellow, with a large black triangle on each side of upper occiput, frons seen from in front with white dusting, ocellar spot black, no black spots on face, antennae except apex of second segment and third around base of arista brownish black, and palpi yellow. Frons over 2.5 times as long as wide; all four verticals strong, normally one pair of reclinate upper and two pairs of weaker lower incurved black orbitals, but frequently the upper pairs are duplicated. Face almost straight in profile, the usual central depression very shallow. A series of short but strong postocular setulae on upper half of occiput.

Thorax shiny black; mesonotum without gray dust; humeri, scutellum, on sides and below at apex, a large triangle on the mesopleura extending from upper anterior angle to almost the lower posterior angle, a small spot on the sternopleura below the lower extremity of the mesopleural triangle, and a round spot on the metapleural convexity ivory-white; posterior notopleural convexity and posterior edge brownish; prosternum yellow. Two notopleurals, one supra-alar, two postalars, and a pair of prescutellars usually present; surface closely piliferous punctate; mesopleural bristles distinct; scutellum convex, subtruncate at apex, with a pair of strong apical bristles.

Legs in male yellow, the mid and hind coxae blackened, and apices of the tarsi infuscated, in female the fore femora from near bases to apices, the mid and hind femora except extreme bases, and all of the mid and hind tibiae glossy black, fore tibiae and tarsi and apices of mid and hind tarsi dark brown. Hind tibia of male with the usual flattened and densely short-haired spot near apex on the posterodorsal surface.

Wings glassy, stigma yellowish, costa from apex of second vein to apex of fourth with a rather faint, narrow, fuscous border, cross veins not clouded and no anal streak present. Free part of anal vein shorter than the lobe of anal cell, especially in the male because of the marginal notch in the wing. Inner cross vein at about two fifths from apex of the discal cell; two to eight or more black setulae on upper side of fifth vein beyond apex of posterior basal cell.

Abdomen glossy black, with a pair of yellow spots on margin of one or more of the tergites, most noticeable on the fourth. Surface hairs pale; male hypopygium larger than usual.

Length, 6.5-7.5 mm.

Henderson Island: northwest side, 100 ft., holotype male, allotype female, and one female paratype, June 21, 1934; north side, 100 ft., one male paratype, June 18, 1934, collected by E. C. Zimmerman.

The difference in the coloring of the legs in the sexes is exceptional, and it might be considered worthwhile to segregate the species in a new subgenus on the character of the setulose fifth wing vein though I do not propose this course here.

Dacus atra, n. sp.

Male and Female. This is the only species known to me in which the entire thorax and scutellum is shiny black.

Head brown, occiput black, facial spots indistinct because of the dark ground color of the face; antennae brownish black, second segment paler, especially at apex; palpi black, paler at base. Frons about twice as long as wide; all four vertical bristles strong, the upper reclinate considerably weaker, and both pairs of incurved lower orbitals subequal in length to the upper. Face with the central depression more marked than in *D. setinervis.*

Thorax glossy black in the male which is slightly teneral; the posterior half of the mesopleura and the metapleural convexity slightly brownish. Mesonotum with hairs brownish yellow, more conspicuous than in *D. setinervis* and showing indications of forming two discal vittae. Chaetotaxy and structure as in *D. setinervis.*

Legs black in both sexes, only the bases of the tarsi brownish yellow.

Wings glassy, stigma yellowish, the costa with a very faint indication of a yellowish tinge; neither cross vein clouded, and no anal streak. Inner cross vein more oblique than in *D. setinervis,* at about two fifths from apex of the discal cell. Free part of the anal vein shorter than the lobe of anal cell. Fifth vein bare.

Abdomen black, with yellow decumbent hairs that lie at different angles in central stripes so that when the abdomen is viewed from different angles they appear to form vittae.

Length, 7-8 mm.

Austral Islands: Raivavae, near Umurau, 100-200 ft., holotype male and two paratypes, August 3, 1934, collected by E. C. Zimmerman.

There is no color distinction in the legs of the sexes of this species. This distinction is not present in *D. carbonarius* Hendel in which the general color is rather similar though the usual yellow thoracic markings are present on the lateral margins of the mesonotum behind the suture, on the mesopleura and the metapleura; the humeri are brown. Hendel's species was described from New Britain.

Dacus incertus, n. sp.

Male and Female. A shiny brownish yellow species, with close resemblance to *D. luteola* Malloch, but with the yellow thoracic marks

much more contrastingly pale than the mesonotum, and but one pair of incurved infraorbital bristles.

Head brownish yellow, with a small black intraocellar spot and a small black triangular mark on each side of occiput; no black facial spots; third antennal segment fuscous except at base; palpi yellow. Vertical and supraorbital bristles black, infraorbital pair brownish yellow. Frons about three times as long as wide; genal bristle brownish yellow.

Thorax with the following ivory-white or very pale yellow markings: Humeri, scutellum, a large subdivided mark on metapleura, the upper part of which is not as pale as the lower, a spot on upper edge of the sternopleura, and a large subtriangular mark that occupies the entire upper and hind margins of the mesopleura; the posterior notopleural convexity hardly paler than the remainder of the mesonotum which is without evident dust or vittae. Chaetotaxy very variable, the supra-alar bristle present or absent, sometimes very weak, or present on one side only, sometimes three postalars, and the scapular bristles weak or strong; scutellars two.

Legs yellow, normal in structure.

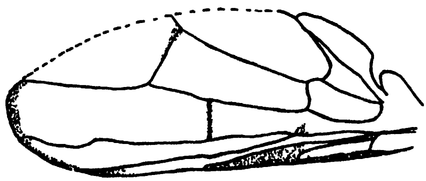

FIGURE 1.—*Dacus incertus*, wing.

Wings glassy, stigma and marginal cell yellowish brown, a brown costal streak starting at apex of second vein and continued to apex of fourth, becoming gradually slightly wider as it advances; both cross veins narrowly pale brown, clouded; anal streak pale, almost obsolete. Inner cross vein oblique, at less than one third from apex of the discal cell (fig. 1). Fifth vein in two or three specimens with one or two very minute setulae on upper side near base of the discal cell. Free part of the anal vein in female about as long as, in male about two-thirds as long as, lobe of cell.

Abdomen with usually a blackish transverse mark on each side near base of each tergite and a small blackish spot in center of each though this is very variable, the markings being sometimes lacking; the basal section of the genital cone in female is always black or dark brown. Hairs pale, the third tergite in male with a lateral apical comb of curled brown bristles; fifth tergite in both sexes with a large oval discal depression on each side of which the hairs are much shorter, finer, and closer together than they are elsewhere on the tergite. Hypopygium of male with an anterior, downwardly directed, stout process that has a short spur on the apex behind, the superior forceps pincerlike, directed downward and finely haired.

Length, 6.5-7.5 mm.

Tuamotu Archipelago: Hao Island, Boring Bay, holotype male, allotype female, and 10 paratypes, May 18-19, 1934, collected by E. C. Zimmerman; Makatea, one male and one female paratype,

mounted in each case with two puparia, from *Guettarda speciosa*, November 5, 1932, collected by G. P. Wilder.

Dacus psidii Froggatt.

A shiny black species with the humeri except the upper margins, the posterior notopleural convexities, lateral edges of the scutellum, a vertical streak on the hind margin of the mesopleura and a spot below on the sternopleura, and a double spot on the metapleura ivory-white or pale yellow. Wings glassy, with the stigma and a very narrow costal clouding brownish yellow, the inner cross vein faintly and the outer one hardly brown clouded; anal streak inconspicuous. Abdomen black, with a pair of brownish yellow vittae on dorsum more or less well developed. Length, 7-8 mm.

Society Islands. Moorea: large series reared from guavas, collected by G. P. Wilder. Tahiti: Mango, January 12, 1929, collected by G. P. Wilder; Mataia, from outer pulp of *Inocarpus edulis*, June 26, 1932, emerged July 16, 1932, collected by G. P. Wilder; near Papeete, eggs laid on guava, March 23, 1934, collected by E. C. Zimmerman; no locality, several specimens from *Nephetium* sp., December 1923, collected by G. P. Wilder.

Genus PAROXYNA Hendel

There are two species of this genus, both apparently undescribed, in the collection of the Mangarevan Expedition.

Paroxyna angustipennis, n. sp.

Male. Belongs to the section of the genus in which the upper supraorbital bristle is white, scutellum has two long basal and two very short apical bristles, head not longer than high, and two small hyaline dots below apex of second wing vein.

Head, including antennae and palpi, orange-yellow, ocellar spot and central part of occiput black, the latter with gray dust, frons with orbits and a complete central vitta silvery white, dusted. Frons a little longer than wide, orbits narrow; ocellar bristles long and strong, outer vertical, upper supraorbital, and moderately long postvertical bristles white, all others black, three pairs of infraorbitals. Gena about one tenth as high as eye, equal to twice the width of parafacial, and about half as high as width of third antennal segment, with one or two long yellow bristles behind and with rather dense, short, stiff, fulvous hairs in front; vibrissal angle slightly produced. Proboscis with apical section as long as head; palpi equally long, lanceolate.

Thorax black, not shiny, uniformly golden brown dusted on dorsum, merging into gray below on sides, scutellum slightly shiny, yellowish at apex, with yellowish brown dusting on disc. All dorsal bristles, one on the mesopleura, and one on the sternopleura, black; all hairs, the pteropleural bristle, and some short posterior mesopleural bristles yellow.

Legs orange-yellow, fore coxae and mid and hind femora partly infuscated. Posteroventral surface of fore femur with a series of widely separated bristles, longest apically.

Wings (fig. 2, *a*) narrower than usual, longer than thorax and abdomen combined, dark brown, with numerous small hyaline spots, stigma dark brown on apical two thirds, pale at base. Halteres yellow.

Abdomen colored and dusted as thorax, apices of tergites slightly yellowish, third and fourth tergites each with a pair of large blackish spots. Fifth tergite as long as the two preceding tergites combined, with a few marginal bristles. Hairs on the fused basal tergites yellow, those on disc of the other tergites black.

Length, 4.5 mm.

Rapa: Mt. Tepiahu, south side, 400-600 feet, July 20, 1934, collected by E. C. Zimmerman.

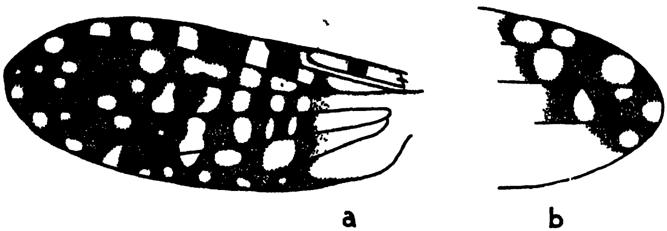

FIGURE 2.—*Paroxyna*: *a*, *P. angustipennis*, wing; *b*, *P. media*, wing.

Paroxyna media, n. sp.

Male and female. Belongs to the same group as *P. angustipennis*, agreeing with it in the armature and shape of the head, and in the scutellar bristling; differing markedly in the wing pattern.

The third antennal segment is slightly darkened but the specimens are greasy so that it is not possible to be certain if this is normal. The frons shows the same white dusted markings as in *P. angustipennis*, but there are only two pairs of infraorbital bristles present.

Thorax greasy in both specimens but apparently with gray dust, bristling as in *P. angustipennis*.

Legs yellow, all coxae and femora almost entirely black, with gray dust.

Wings (fig. 2, *b*) not as narrow as in *P. angustipennis*, dark brown, with larger hyaline spots, the stigma entirely dark brown and a single large hyaline spot below apex of the second vein.

Abdomen greasy in both specimens, genital cone of the female glossy black.

Length, 3 mm.

Rapa: type female, Morongota, 700-800 feet, July 11, 1934; allotype, east ridge of Mt. Perahu, 1,200-1,500 feet, July 21, 1934, collected by E. C. Zimmerman.

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV July 20, 1938 Number 8

Notes on Hawaiian Species of Lobelia
Hawaiian Plant Studies 5[1]

By HAROLD ST. JOHN AND EDWARD Y. HOSAKA

LOBELIA GAUDICHAUDII AND ITS RELATIVES

The Lobeliaceae are represented in the Hawaiian islands by five endemic genera and one indigenous genus, *Lobelia,* with endemic species. The endemic species and varieties total 154. Many of them are trees or vigorous shrubs with large and beautiful flowers. They abound in the rain forests and the high bogs.

In 1937 E. Y. Hosaka and F. R. Fosberg discovered a small bog in the cloud zone on the Koolau Range, Oahu. Growing there was a striking lobeliad with numerous tall racemes. This was described as *Lobelia Gaudichaudii* A. P. DC. var. *koolauensis* Hosaka and Fosberg. Consideration of this variety has resulted in the revision of the species and its relatives. The plants are rather uniform in stout, shrubby habit and general appearance, but differ in the size and shape of the calyx lobes, the size and shape of the floral bracts, the pubescence of the herbage and inflorescence, and the color of the flowers. When classified on this basis, it is evident that each of the varieties and forms is restricted in its occurrence to a single island, Kauai, Oahu, or Maui.

Key to *Lobelia Gaudichaudii,* its Varieties and Relatives

Corolla 4.5-9 cm. long[2]; floral bracts not cordate; upper leaves obovate to oblong-linear, not cordate at base; plant glabrous or somewhat pubescent but not villous throughout,

[1] This is the fifth of a series of papers designed to present descriptions, revisions, and records of Hawaiian plants. The preceding papers have been published as B. P. Bishop Mus., Occ. Papers, **10** (4), 1933; **10** (12), 1934; **11** (14), 1935; **12** (8), 1936.
[2] Corolla measured along the arc of the curve.

Calyx lobes 1.2-2.2 cm. long,
  Inflorescence not villous throughout,
    Floral bracts 2.2-3.5 cm. long, 6-10 mm. wide,
      Leaves all or some of them with midrib hirsute beneath; raceme usually single..**L. Gaudichaudii** var. **typica.**
      Leaves all glabrous beneath; stem usually with several terminal racemes,
        Flowering branch naked or with a few reduced bracts...var. **koolauensis.**
        Flowering branch leafy,
          Herbage glabrous..var. **kauaensis.**
          Herbage pilose throughout or in part....................................f. **hirsuta.**
    Floral bracts 3-4.5 cm. long, 0.8-2 cm. wide,
      Calyx lobes ciliate,
        Corolla cream-colored with faint purplish streaks...var. **gloria-montis.**
        Corolla crimson...f. **sanguinea.**
      Calyx lobes not ciliate ....f. **kukuiensis.**
  Inforescence villous throughout; bracts 3-4.5 cm. long.................f. **Bryanii.**
Calyx lobes 2.2-3.5 cm. long...var. **longibracteata.**
Corolla 3.5-4.5 cm. long; floral bracts ovate or cordate; upper leaves cordate to subcordate; plant villous throughout....................................**L. villosa.**

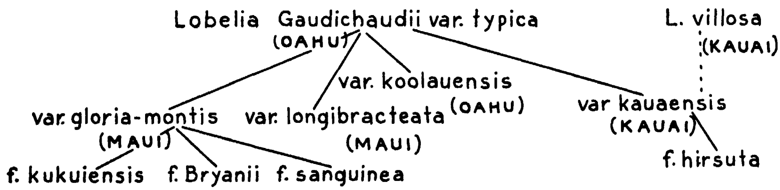

FIGURE 1.—Diagram showing interrelationship of the *Lobelia Gaudichaudii* group.

Lobelia Gaudichaudii A. P. DC., Prodr. **7**: 384, 1838.

An erect plant up to 2 m. tall, glabrous or pubescent, stem hollow, covered with leaf scars; leaves clustered at apex of stem, linear-lanceolate to oblong-lanceolate, coriaceous to subcoriaceous, sessile, margin revolute or thickened; inflorescence a raceme, simple or branching, with floral bracts; flowers curved; corolla 3.5-9 cm. long, white to crimson, splitting into 5 segments; staminal column glabrous; anther bearded at tip, stigma two-lobed, oval, slightly exserted beyond the anther; capsule ovoid or pyriform, glabrous or pubescent, with an acuminate conical apex.

Lobelia Gaudichaudii A. P. DC. var. **typica** St. John and Hosaka, var. nov.

Lobelia Gaudichaudii A. P. DC., Prodr. **7**: 384, 1838.

Lobelia Gaudichaudii A. P. DC. var. *coccinea* Rock, Torrey Bot. Club, Bull. **44**: 238, 1917.

An erect glabrous plant with stem 30-80 cm. tall, 2.5-4 cm. in diameter, hollow, covered with leaf scars; leaves 15-21 cm. long, 1.5-2.5 cm. wide, oblong-lanceolate, acute at apex, broadly sessile, coriaceous, pale green or purplish beneath, margin revolute or thickened, upper part with callous teeth, base glabrous or sparsely ciliate, midrib large, glabrous or densely hirsute; inflorescence a single raceme or rarely 2-3-branching; rhachis glabrous; raceme leafy at base, bracteate above, floral bracts 2.2-3.2 cm. long, 6-10 mm. wide, oblanceolate, glabrous or sparsely ciliate, purplish; pedicels 2.3-5 cm. long, glabrous, green or purplish; calycine tube 4-8 mm. long, campanulate to hemispheric, glabrous, calyx lobes 1.2-2 cm. long, 4-6 mm. wide, glabrous, green or purplish; corolla 5-8 cm. long, 6-13 mm. wide, glabrous, deep rose-colored, the two lateral lobes splitting two thirds way down, linear, lower lip shortly trifid; staminal column glabrous, red; anther sac glabrous, violet-rose, tip bearded; stigma two-lobed, oval, slightly exserted beyond the anther; capsule 1.5-2 cm. high, 1-1.5 cm. wide at middle, conspicuously fringed with calyx lobe scars, ovoid or pyriform, with an acuminate, conical apex, lower portion with pronounced veins; seeds 1-1.2 mm. long, 0.5 mm. wide, ovate-reniform, compressed, shining, center dark, with narrow, brownish coriaceous margin.

Type: ad cacumen montis O-Wahu Sandwicensium (Gaudich.-[aud] 1837). J. F. Rock states that the type specimen in Herb. Paris is *Gaudichaud no. 149.*

Range: restricted to the Koolau Range, Oahu, Hawaiian islands.

Oahu: summit of Konahuanui, Mar. 11-12, 1915, *C. N. Forbes 2180.O,* and *2182.O* ; top of Poamoho Trail, Koolau Range, alt. 800 m., Nov. 22, 1936, *F. R. Fosberg 13330*; Lanihuli Peak, Feb. 29, 1920, *D. W. Garber 261* and *262*; Peak of Mount Konahuanui, Nov. 23, 1919, *Garber 82*; Kipapa Gulch, Koolau Range, alt. 2,800 ft., Sept. 18, 1932, *E. Y. Hosaka 686*; Mount Lanihuli, Sept. 1914, *Nelson and Stone 10003*; Konahuanui, Sept. 1912, *J. F. Rock 10003*; Punaluu Mts., Dec. 3, 1908, *Rock 64*; Punaluu Mts., Dec. 3-14, 1908, *Rock 65*; Summit of Konahuanui, Sept. 1912, *G. W. Shaw 12742* (type of var. *coccinea*) ; Waipio-Waiahole divide, Kipapa Gulch, Waipio, alt. 2,800 ft., Sept. 18, 1932, *H. St. John 12077*; same locality, April 24, 1938, *St. John 18905.*

As Rock later pointed out [B. P. Bishop Mus., Mem., 7 (2) : 117, 1919], his *L. Gaudichaudii* var. *coccinea* was an exact synonym of *L. Gaudichaudii* A. P. DC. He was misled by an aggregate confused description in Hillebrand's "Flora of the Hawaiian Islands", and mistook a Maui plant for *L. Gaudichaudii.* He later detected this confusion, realized that Gaudichaud's type was the Oahu species and reduced his variety to synonomy under *L. Gaudichaudii.* Rock's variety *coccinea* was an illegitimate name, being superfluous when published [Int. Rules Bot. Nomen., 3d. ed., art. 60 (1), p. 19, 1935],

and hence has no standing in nomenclature. In a species having as many variations as this, it is desirable to assign a subdivisional name to the original one. Rock's varietal name is not only illegitimate but undesirable, because if restored it would make Rock's instead of Gaudichaud's earlier collection the type. Hence, we reject Rock's name and coin a new varietal name, variety *typica*.

Lobelia Gaudichaudii A. P. DC. var. **koolauensis** Hosaka and Fosberg, B. P. Bishop Mus., Occ. Papers, **14** (1): 4, 1938.

Plants 1-1.5 m. tall, stem unbranched, 3-4 cm. in diameter, leaves clustered at apex of stem; leaves 12-17 cm. long, 2-2.5 cm. wide, glabrous, coriaceous: inflorescence branching candelabrum-like, glabrous, the 3-6 racemes 40-50 cm. long, with 20-35 flowers, the axis bracteate but leafless; floral bracts 2.5-3 cm. long, 7-10 mm. wide, coriaceous, glabrous, pedicels 2.5-4.3 cm. long, glabrous; calyx tubes 8-11 mm. long, broadly obconical, glabrous, the lobes 10-15 mm. long, 3-6 mm. wide, lanceolate, glabrous; corolla 5.8-6.5 cm. long, 1.8-2 cm. wide, whitish to whitish green, glabrous; staminal column glabrous; anthers glabrous, the tips all bearded; stigma two-lobed, bearded.

Type: Oahu, Koolau Range, divide between head of Kawainui Gulch and Kaipaupau Gulch, alt. 860 m., on open, windswept, sloping bog, June 1, 1937, *Hosaka and Fosberg 1915* (type in Bishop Mus.).

Range: known only from the type locality on the Koolau Range, Oahu, Hawaiian islands.

Oahu: Koolau Range, divide between head of Kawainui and Kaipaupau Gulches, in open bog, alt. 860 m., July 24, 1937, *Fosberg and F. E. Egler 14224*.

Lobelia Gaudichaudii A. P. DC. var. **kauaensis** Gray, Am. Acad., Proc. **5**: 150, 1862 (published as var. *Kauaensis*).

Lobelia kauaensis (Gray) Heller, Minn. Bot. Stud., **1**: 911, 1897.

An erect plant 1-2 m. tall; stem covered with leaf scars; leaves 15-30 cm. long, 1.5-3 cm. wide, linear-lanceolate, glabrous; inflorescence of 2-5 racemes, glabrous; leaves of flowering branches linear-lanceolate; floral bracts 1.5-2.5 cm. long, 4-8 mm. wide, glabrous; calyx lobes 0.8-1.2 cm. long, 3-5 mm. wide; corolla 4.5-6 cm. long, glabrous, white with purplish veins.

Type: Kauai, U. S. Expl. Exped. The type is in the U. S. Nat. Herb.

Range: restricted to the high mountain bogs of Kauai, Hawaiian islands.

Kauai: Hanapepe, alt. 800 m., Dec. 1909, *A. Faurie 552*; Wahiawa Swamp, Aug. 1909, *C. N. Forbes*; Waialeale, Sept. 1909, *J. F. Rock 5109*; Waialeale, Oct. 21, 1916, *Rock 12845*; Kahili Swamp, Wahiawa,

Lihue-Koloa Forest Reserve, alt. 2,100 ft., Dec. 29, 1930, *H. St. John and others 10849*; Kahili Bog, Wahiawa, alt. 2,100 ft., Dec. 24, 1933, *H. St. John and F. R. Fosberg 13561.*

In 1937, a plant with characters intermediate between *L. Gaudichaudii* var. *typica* and *L. kauaensis* was discovered on Oahu. The characters that had been used to separate *L. Gaudichaudii* var. *typica* from *L. kauaensis* were combined in this new plant. Also the finding of a branching form of a typical *L. Gaudichaudii* (not *L. Gaudichaudii* var. *koolauensis*) made the separation more difficult. Because of these facts *L. kauaensis* is reduced to a variety of *L. Gaudichaudii.*

This variety can be distinguished from the species by always having a branching inflorescence, glabrous and smaller leaves, smaller calyx lobes and smaller flowers.

This plant was included by Hillebrand in his concept and description of *L. Gaudichaudii*; but, as has been shown, that species is restricted to Oahu.

The type of *L. Gaudichaudii* A. P. DC. var. *kauaensis* Gray was collected on Kauai by the U. S. Exploring Expedition under Captain Wilkes. The writers have not seen the type, but the isotype in the Gray Herbarium was studied and discussed by Rock.

Lobelia Gaudichaudii A. P. DC. var. **kauaensis** Gray f. **hirsuta,** St. John and Hosaka, f. nov.

Racema hirsuta. Pedicellus hirsutus. Bracteae florosae ciliatae. Lobae calycis ciliatae.

Plant habit similar to the variety, racemes brown hirsute; floral bracts and calyx lobes with ciliate margin; pedicels hirsute.

Type: Kauai, Waialeale, Oct. 1916, *J. F. Rock 12845a* (type in Bishop Mus.).

Range: restricted to Mt. Waialeale, Kauai, Hawaiian islands.

Kauai: Waialeale, Oct. 21, 1916, *Rock 12845* (two fruiting branches of this form mounted on the same sheet with a flowering branch of the variety).

This form is distinguished from the variety by being hirsute. Rock, in his description of *L. kauaensis* [B. P. Bishop Mus., Mem. 7 (2) : 119, 1919], included this hirsute form. The hirsute plant is distinct and no intermediates are known.

Lobelia Gaudichaudii A. P. DC. var. **gloria-montis** (Rock) St. John and Hosaka, comb. nov.

Lobelia gloria-montis Rock, B. P. Bishop Mus., Mem., 7(2) : 117, pl. 58, 1919.

Stem 1-1.5 m. tall; leaves 15-18 cm. long, 2.8-4 cm. wide, glabrous on both surfaces, usually ciliate at the margins near base; floral bracts broadly spatulate to obovate, 3-4 cm. long, 1.7-2.2 cm. wide, conspicuously denticulate near the apex, ciliate below; pedicels 3-4 cm. long; calyx lobes 1.5-2 cm. long, 4-7 mm. wide, ciliate on margin; corolla 7-9 cm. long, glabrous, about 2 cm. wide at the widest part, cream-colored with faint purplish streaks.

Type: W. Maui, elev. 5,700 ft., Puu Kukui Mt.; Aug. 1910, *J. F. Rock and J. S. Hammond 8209* (type in Bishop Mus.).

Range: restricted to the summit bogs of western Maui, Hawaiian islands.

Maui: top of mountain of West Maui, *H. Mann and W. T. Brigham 462*; Puu Kukui, open bogs, alt. 5,000-5,700 ft., Feb. 7, 1930, *H. St. John 10274.*

This variety of western Maui differs from the var. *typica* in several regards, but some of the characters overlap, so the writers think the variation is not significant enough to maintain the plant as a species. *L. Gaudichaudii* var. *gloria-montis* has floral bracts 1.7-2.2 cm. wide, midrib and leaf glabrous, and the flowers cream-colored. *L. Gaudichaudii* var. *typica* has floral bracts 6-10 mm. wide, midrib of leaf usually densely hirsute, flowers deep red-purple.

This plant was erroneously included by Hillebrand in his description of *L. Gaudichaudii,* which species or its variety *typica* is restricted to Oahu.

Lobelia Gaudichaudii A. P. DC. var. **longibracteata** Rock, Coll. Haw., Bull. 2: 47, 1913.

Lobelia gloria-montis Rock var. *longibracteata* Rock, B. P. Bishop Mus., Mem., 7 (2) : 119, 122, pl. 59, 1919.

Plants 3-5 m. tall, glabrous throughout; leaves 18-20 cm. long, 3-3.5 cm. wide, glabrous, oblong-lanceolate, nearly of even width, coriaceous; inflorescence terminal, of 5-7 racemes; floral bracts 6-7.5 cm. long, 8-10 mm. wide, linear-lanceolate, glabrous except for the margin which is sparsely ciliate at base; calyx lobes 2.8-3.5 cm. long, 5-8 mm. wide, lanceolate, glabrous except for the margin which is ciliate at base; corolla 6.5-7.5 cm. long, glabrous.

Type: W. Maui, elev. 5,780 ft., Mt. Puu Kukui, Aug. 1910, *J. F. Rock 8818* (type in Bishop Mus.).

Range: restricted to forest at summit of Puu Kukui, western Maui, Hawaiian islands.

Maui: known only by the type collection of several sheets.

Judging from the materials available, this variety is very distinct from the var. *typica,* and almost deserves a specific rank. It can be recognized easily by the long floral bracts and long calyx lobes.

Lobelia Gaudichaudii A. P. DC. var. **gloria-montis** (Rock) St. John and Hosaka f. **Bryanii,** St. John and Hosaka, f. nov.

Planta stricta 1.5-2 m. alta. Inflorescentia fulva hirsuta. Pedicellus hirsutus. Tubus calycis dense hirsutus. Lobae calycis dense hirsutae.

An erect unbranched plant 1.5-2 m. tall; leaves 13-16 cm. long, 2.5-3.5 cm. wide, oblong, spathulate, sessile; raceme single, 40-60 cm. long, hirsute, brownish when dry; bracts hirsute on both surfaces; pedicels hirsute; calyx tubes and lobes densely hirsute; corolla sparsely pilose.

Type: W. Maui, Puu Kukui, May 1910, *C. N. Forbes 68.M* (type in Bishop Mus.).

Range: restricted to the high bogs of the mountains of western Maui, Hawaiian islands.

Maui: Puu Kukui, edge of open bogs, alt. 5,200 ft., Dec. 18, 1928, *E. H. Bryan, Jr. 632.*

Lobelia Gaudichaudii var. *gloria-montis* f. *Bryanii* differs from the variety in several characters. It has a hirsute spike; the pedicels, calyx tubes, and calyx lobes densely brown hirsute; and the petals sparsely pilose. *L. Gaudichaudii* var. *gloria-montis* has glabrous spikes, pedicels, calyx tubes, calyx lobes, and petals.

This form is named for Mr. E. H. Bryan, Jr., Curator of Bishop Museum, who has inspired many people to appreciate nature.

Lobelia Gaudichaudii A. P. DC. var. **gloria-montis** (Rock) St. John and Hosaka f. **sanguinea** St. John and Hosaka, f. nov.

Florae coccinae.

Habit of plant similar to the variety; flowers crimson.

Type: W. Maui, Puu Kukui, in swamp, alt. 4,500 ft., Aug. 16, 1933, *C. E. Hartt* (type in Bishop Mus.).

Range: restricted to the summit bogs of the mountains of western Maui, Hawaiian islands.

Maui: Puu Kukui, summit bog, alt. 1,850 m., Oct. 9, 1922, *C. Skottsberg 773.*

This form can be easily distinguished from the variety by the crimson flowers. The variety has cream-colored flowers with faint purplish streaks.

Lobelia Gaudichaudii A. P. DC. var. **gloria-montis** (Rock) St. John and Hosaka f. **kukuiensis** St. John and Hosaka, f. nov.

Bractae florosae 2-4 cm. longae, 0.7-1 cm. latae. Lobae calycis glabrae.

Plant similar to the variety; floral bracts 2-4 cm. long, 0.7-1 cm. wide; calyx lobes glabrous; corolla about 1 cm. wide.

Type: W. Maui, Haelaau-Puu Kukui trail, alt. 4,400 ft., Dec. 19, 1928, *G. R. Ewart III 89* (type in Bishop Mus.).

Range: restricted to the mountains of western Maui, Hawaiian islands.

Maui: Puu Kukui, Dec. 1928, *E. H. Bryan, Jr.*; Honokahau drainage basin, Sept. 25-Oct. 17, 1917, *C. N. Forbes 456.M.*; Puu Kukui, Sept. 25, 1916, *G. C. Munro 615*; summit of Mount Eeke, Sept. 1918, *J. F. Rock and J. Hashimoto.*

This form differs from the variety in having narrower flowers, narrower floral bracts, and glabrous calyx lobes.

Lobelia villosa (Rock) St. John and Hosaka, comb. nov.

Lobelia kauaiensis (*kauaensis*) (Gray) Heller var. *villosa* Rock, Torrey Bot. Club, Bull. **44**: 237, 1917.

An upright plant with stem 60-100 cm high and about 3 cm. across, stem closely covered with leaf scars; lower leaves 9-14 cm. long, 2.5-4 cm. wide, oblong, with winged petiole, broadly sessile, with thick prominent midrib and obscure veins, sub-acute at apex, glabrous below except the margin and midrib which are villous, revolute, upper leaves gradually reduced to foliaceous, cordate to subcordate bracts, oblanceolate, acute at apex, sparsely to densely villous on both surfaces, coriaceous margin revolute; inflorescence candelabrum-like, of several racemes, many-flowered, branches 40-60 cm. long, sparsely to densely villous; floral bracts 2-3 cm. long, 1.4-2 cm. wide, cordate or ovate, broadly sessile, entire, densely villous; pedicel 2.5-3 cm. long, slender, densely villous; calycine tube 0.5-0.8 mm. high, 10-14 mm. wide, villous, obconical, lobes 1-1.5 cm. long, 4-5.5 mm. wide, lanceolate, glabrous to sparsely pubescent, margin ciliate, purplish-tinged; corolla 3.5-4.5 cm. long, 8-12 mm. wide at the widest part, glabrous, whitish green with purplish veins, two lateral lobes splitting down two thirds of the length, linear, the lower lip shortly trifid; staminal column glabrous; anthers glabrous, all bearded at tip; capsule dark, villous, pyriform, with an acuminate conical apex; seed oblong-reniform, compressed, brownish, glossy, margin thickened.

Type: Kauai, Waialeale, Oct. 21, 1916, *J. F. Rock 12844* (type in Bishop Mus.). Rock gives the above data on the type specimen in the Bishop Museum but gives Mt. Waialeale, Oct. 21, 1916, *J. F. Rock and A. S. Hitchcock 12741* in the original publication. *Rock 12844* and *Rock and Hitchcock 12741* refer to the same collection.

Range: restricted to the summit bogs of Mt. Waialeale, Kauai, Hawaiian islands.

Kauai: Alakai swamp, Waimea drainage basin, west side, July 3-Aug. 18, 1917, *C. N. Forbes 1122.K.*; Waialeale, Sept. 23, 1909, *Rock 5823*; Waialeale, Oct. 1911, *Rock*; Waialeale, alt. 5,200 ft., Oct. 21, 1916, *Rock 12844.*

Rock, who has seen this plant growing in its natural habitat, says that the whole aspect of the plant is different from var. *kauaensis.* The writers have examined a large number of specimens of the two plants and find that Rock's variety is decidedly different from both *L. Gaudichaudii* and the var. *kauaensis,* so his variety is here raised to a species. *L. villosa* differs from *L. Gaudichaudii* var. *typica* and *L. Gaudichaudii* var. *kauaensis* in many characters. It is villous throughout with corolla 3.5-4.5 cm. long; floral bracts ovate or cordate, villous; pedicels densely villous; leaves 2.5-4 cm. wide, oblong, margin and vein villous. *L. Gaudichaudii* var. *kauaensis* is glabrous throughout; with corolla 4.5-6 cm. long; floral bracts linear-lanceolate, glabrous or ciliate on the margin; pedicels glabrous; leaves 1.5-3 cm. wide, linear-lanceolate. *Lobelia Gaudichaudii* var. *typica* is glabrous throughout, corolla 5-8 cm. long, 6-10 mm. wide; floral bracts oblanceolate, glabrous; leaves 1.5-2.5 cm. wide, oblong-lanceolate, usually with densely hirsute midrib.

A NEW VARIETY OF LOBELIA HYPOLEUCA

Lobelia hypoleuca Hillebr. var. **Rockii** St. John and Hosaka, var. nov.

Planta 1-2 m. alta. Antherae glabrae.

Plant 1-2 m. tall; leaves densely woolly beneath; inflorescence branching; flowers bluish; anthers glabrous.

Type: Oahu, Koolau Range, Punaluu, alt. 2,000 ft., Sept. 28, 1930, *E. Y. Hosaka 312* (type in Bishop Mus.).

Range: restricted to wet forests of the Koolau Range and the Waianae Mountains, Oahu, Hawaiian islands.

Oahu: Kaaumakua, alt. 1,700 ft., in moist wood on slope, Feb. 22, 1928, *H. F. Bergman*; Koolauloa Mts., between Punaluu and Kaipaupau, Nov. 14-21, 1908, *C. N. Forbes and J. F. Rock*; Lanihuli, Oct. 14, 1908, *Forbes*; Paalaa-Wahiawa Divide, wet scrubby forest, alt. 750 m., Nov. 22, 1936, *F. R. Fosberg 13323*; Mount Konahuanui, Olympus Trail, near Pauoa Valley rest house, Nov. 23, 1919, *D. W. Garber 89*; Waianae Mts., Puu Kaala, alt. 3,500 ft., Aug. 24, 1924, *J. A. Harris C242132*; Kipapa Gulch, S. ridge, at head of gulch, alt.

1,800 ft., Oct. 16, 1932, *Hosaka 797*; Punaluu Trail, alt. 2,000 ft., Nov. 14, 1908, *Rock 808*; same locality, Nov. 14-21, 1908, *Rock 807*; Kaluanui, open woods, near ridge, alt. 2,100 ft., Nov. 30, 1929, *H. St. John 10103*; Punaluu, rain forest, alt. 2,000 ft., Jan. 10, 1931, *W. B. Storey*; Waikane-Schofield Trail, alt. 1,250-2,400 ft., Oct. 16, 1932, *A. Suehiro*; Mount Olympus, Aug. 26, 1913, *O. H. Swezey*.

Hillebrand (Flora Haw. Is., 238, 1888) described *Lobelia hypoleuca* from specimens collected on Maui at Wailuku [south ridge, Wailuku Valley, western Maui, Aug. 1870] and Lahaina; Oahu, Waialua and Halemano; Molokai, pali of Pelekunu; Hawaii, woods of Kohala, but he did not indicate any type specimen. Dr. St. John, while in Berlin, Germany, examined Hillebrand's specimens and found the fruiting one collected at Wailuku marked *Lobelia hypoleuca* n. sp. in Hillebrand's handwriting, so this specimen is properly designated as the type. The specimens from western Maui in the Bishop Museum have hirsute anthers. Hillebrand described *L. hypoleuca* as with "anthers glabrous", but this character was taken from the flowering specimens from Oahu. We have studied this group and found that the glabrous or hirsute character of the anther is a constant and distinct one. From the available materials in the herbarium of Bishop Museum it appears that those with hirsute anthers were found on Lanai and Maui, while those with glabrous anthers were restricted to Oahu. Therefore we are making the Oahu plant a new variety of the Maui and Lanai one which is the true *L. hypoleuca*.

EXCLUDED PLANTS

It is apparent that *L. Gaudichaudii* or some of its variations occur on the island of Molokai. On his distributional table in his monograph [B. P. Bishop Mus., Mem., 7 (2): 82, 1919] Rock indicates the species from Molokai; and his plate 15 shows an old fruiting plant without leaves, on the cliffs of Pelekunu. Rock apparently did not collect a specimen. What seems to be this same plant has recently been described as *L. gloria-montis* var. *molokaiensis* Degener (Fl. Haw., fam. 339, Feb. 11, 1938). The description is: "About 4 dm. high. Leaves about 12 cm. long and 15-18 mm. wide, entirely glabrous. Flowers unknown." Papaala Pali, Molokai, Degener 7.778. Degener's type had no flowers. Until more complete material is available it is impossible to evaluate properly this Molokai plant.

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV October 1, 1938 Number 9

Monograph of the Genus Nesoluma (Sapotaceae)*

A Primitive Polynesian Endemic of Supposed Antarctic Origin

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RIJKSHERBARIUM, LEYDEN, NETHERLANDS

CONTENTS

MATERIAL

In 1935, the Director of Bernice P. Bishop Museum kindly put at our disposal the sapotaceous plants collected by the Mangarevan Expedition. Among them[1] we found several representatives of a peculiar genus which were studied in detail by Mr. Meeuse. At first we could not identify the genus and we considered it a new one until I paid a short visit to the Paris Herbarium (Muséum National d'Histoire Naturelle, Phanérogamie). During my investigations there I was fortunate enough to come upon some specimens of *Chrysophyllum polynesicum* Hillebr. (*Nesoluma polynesicum* H. Baill.) which I recognized as belonging to the same genus. The Director

* Mangarevan Expedition Publication 25.
[1] With some other interesting or critical Sapotaceae from the Pacific islands, Mr. Meeuse and I intend to deal shortly in a separate paper.

of the Paris Herbarium, Professor H. Humbert, kindly put those specimens at my disposal for closer examination. Likewise I received for study the collections from the herbarium of the Royal Botanical Gardens at Kew, Hillebrand's original material preserved in the herbarium of the Botanischer Garten und Museum at Berlin, and all *Nesoluma* material available in the herbarium of Bernice P. Bishop Museum. In addition to this, material from the Gray Herbarium at Cambridge (Mass.), from the herbarium of the New York Botanical Garden, from the U. S. National Herbarium at Washington, D. C., from Dr. Vladimir Krajina at Prague, and from Mr. Otto Degener at Waialua, Oahu, was kindly sent on loan for study. I wish to extend my thanks to the directors of the institutions mentioned and to Dr. Krajina and Mr. Degener for their valuable assistance.

The Paris material (P) contains two species of the genus *Nesoluma* H. Baill., *N. polynesicum,* the type species, and *N. Nadeaudi.* The Berlin collection (B) contains only some fine sheets of *N. polynesicum* among which is the type specimen, a small fragment of which is also preserved at Paris. The Kew Herbarium (K) was found to possess a fragment of *N. polynesicum* attached to a sheet of "*Sapota sandwicensis*" from the Hillebrand collection. The New York Botanical Garden (NY) possesses eight sheets of *N. polynesicum,* including specimens collected by A. F. Judd, J. F. Rock, C. N. Forbes, and O. Degener. The Gray Herbarium (G) has material of *N. polynesicum* from the collections of J. F. Rock (eight sheets) and also one sheet from the Hillebrand collection, apparently from the same specimen that has been quoted as the "second specimen in the Berlin Herbarium". The U. S. National Herbarium (US) possesses five duplicate specimens of *N. polynesicum* and, in addition, a sixth specimen, attached to the same sheet as a duplicate from Hillebrand's collection but belonging to another variety. Dr. Krajina's material (Kr) contains one specimen of *N. polynesicum.* Mr. Degener's herbarium contains five fine specimens of *N. polynesicum.* The Bishop Museum material (H), both from the Mangarevan Expedition and from older collectors, is by far the richest and enabled me to gain an insight into the complicated systematic structure of this remarkable genus. It appeared to contain a third species, *N. St.-Johnianum,* provisionally considered as new. Its type is preserved at Honolulu, while fragments of this type and of several other specimens were given to the Rijksherbarium at Leyden (L).

NESOLUMA

Description

Nesoluma H. Baill., Soc. Linn. Paris, Bull. **2** (121) : 964, 1891, nomen tantum; Hist. d. Pl., **11** : 279, 1892, descr. latina.—Brown, B. P. Bishop Mus., Bull. **130** : 223, 1935.

Chrysophyllum L., sect. *Pleio-Chrysophyllum* Engler, in Engler's Bot. Jahrb. **12** : 520, 1890; Engler und Prantl, Nat. Pflanzenfam., Teil IV, abt. 1 : 149, 1897; Nachträge I : 278, 1897.

Descriptio aucta et emendata:

Arbores parvae laticiferae. Folia alterna exstipulata coriacea petiolata rigida, basi acuta rarius subrotundata, marginibus integra, apice rotundata vel obtusa, nervis tenuibus, reticulatione perminuta saepe areolata. Inflorescentiae in foliorum vel eorum cicatricium axillis fasciculatae. Flores pedicellati, heteromeri, hermaphroditi vel abortione unisexuales (♀). Sepala plerumque 4 inaequalia, nonnunquam 5, rarissime 3 vel 6, aestivatione aperta vel imbricata. Corollae hypogynae vix exsertae variabilis tubus brevissimus, petala valde imbricata (4-)8-10(-12), saepe nonnulla minora petaloidea vel staminodioidea, in floribus femineis androeceo nullo valde reducta. Stamina uniserialia antheris extrorsis (6-)8-10(-12), filamenta saepe extrorso-reflexa corollae ima basi inserta, interdum nonnulla minora vel sterilia, petaloidea vel staminodioidea. Staminodia alternipetalia, si adsunt, petalis et staminibus reductis similia. Pistillum disco distincto privatum basi saepe glabrum, ovario (2-)3-5(-6)-loculato et -ovulato pilosum, stylo subulato vel conico glabrum. Ovula adscendentia, apotropa, ½-totaliter anatropa, loculorum axis basi affixa. Fructus baccati monospermi. Semina testa ossea, cicatrice basilaterali vel fere basali magna suborbiculata, micropyle hylo haud valde approximata. Albumen copiosum cotyledones plano tangentiali et obliquo positas includens. Radicula infera haud exserta.

Small or moderate-sized trees with latex; branches slender, the ultimate innovations rusty or reddish pubescent, adult parts usually glabrous or nearly so or the leaves remaining somewhat pubescent below; stipules none or at least very caducous and inconspicuous. Leaves petiolate, rigid, coriaceous, more or less shining above, more dull underneath, often light greenish or yellowish, or brownish when dry, elliptic or ovate to oblong, rarely oblanceolate, base acute, rarely subrotundate, margins entire, apex obtuse, rounded or more rarely somewhat emarginate; midrib prominent below, secondary nerves

very slender, not prominent, straight, near the margin more or less irregularly high-arched and joined, often with one or two still more slender ones between; reticulation very minute underneath, areoles usually circular, less conspicuous only in some specimens of *N. polynesicum.* Inflorescences fasciculate in the axils of the leaves or their scars, 1- to many-flowered, sometimes on tuberculate dwarf shoots, the bracts very small, semi-ovate or sublanceolate, tomentose or subglabrous. Flowers pedicellate, glabrous except rarely the pedicels, the outer sepals (or the tips of all sepals) and the anthers, more or less heteromerous, hermaphroditic, or unisexual (♀) by abortion. Sepals usually 4, the outer ones smaller, thicker, and deltoid, the inner ones larger, thinner, imbricate, and ovate to ovate-deltoid, the sepals of each pair often not strictly opposite and usually unequal in size; or 5 sepals extant, very rarely 6 or 3 sepals extant, transition forms between sepals and petals extremely rare. Corolla hypogynous, in hermaphroditic flowers with a very short tube and (4-)8-10(-12) imbricate, ovate or obovate petals, sometimes some of these smaller, outside or inside the others and more or less epipetalous, if inside then often differently shaped, namely either with narrowed tip or ± tridentate; in female flowers the corolla usually reduced either to 1-8 free or slightly connate, subulate petaloid small petals (or even abortive?), or to a whorl of irregularly dentate staminodioid petals. Stamens wanting in female flowers, in hermaphroditic ones inserted in the very base of the corolla tube, uniseriate, extrorse, (6-)8-10(-12), not strictly epipetalous, often two or more before a petal and some of them smaller or more or less sterile, in the latter case either staminoid or petaloid (same shape as the acuminate petals but occupying the place of a stamen); filaments subulate and mostly outwardly reflexed at apex; anthers extrorse, dorsifix, oblong, the sacs sometimes with small apical protrusions, more or less laterally dehiscent, alternipetalous staminodes as found in *Sideroxylon,* etc., if any, not distinguishable from sterile petaloid stamens or from reduced petals or stamens except by their position. Pistil oblong, the base often but not always glabrous (gynophore), without a disc, or with a slight indication of an adnate disc, ovary hispidly adpressedly pilose, (2-)3-5(-6)-celled, apex gradually tapering into the short and stout, glabrous truncate style, which is not or hardly exserted from the flower; cells uni-ovulate[2], ovules attached at the base of the central

[2] An apparently anomalous specimen with bi-ovulate cells is mentioned under *N. polynesicum* (p. 146).

axis, half to more or less fully anatropous and apotropous. Fruits small, baccate, pointed at apex, the more or less spreading calyx not or scarcely enlarged, pericarp thin, surrounding the solitary seed[3], which is narrower or at least flattened in the basal part, and has a thick and hard, shining, crustaceous testa, with a large, broad, basal to basilateral scar including a small basilateral hilum and veined inside; upper limit of scar sinuous or round, the scar, if basilateral, abruptly receding below this line; embryo with the foliaceous cotyledons almost completely surrounded by an abundant albumen, plane tangential and oblique toward the flower axis; radicle inferior, cylindrical, not exserted.

The embryo was examined in all of the species. The plane of the cotyledons proved to be oblique to tangential (not radial), as in *Lucuma occidentalis* H. J. Lam (13, p. 229, fig. 62, *i*[4]) and in *Palaquium pseudorostratum* H. J. Lam (14, pp. 393-394, fig. 3, *l, m*); in addition, its main axis is not vertical but makes an angle of about 45 degrees toward the flower axis (cf. *Calvaria*, where it is horizontal).

Discussion

This remarkable genus, the restoration of which is responsible for a new realignment of the whole order, is a fine example of the complexity of the floral features in the Sapotaceae. This complexity has already been pointed out in a most eloquent way by Dubard in the first issue of his series of elaborate papers (4, p. 292). Recently Eyma (9, pp. 156-159, 192-193) has given more examples of complications in the Sapotaceae: in the genus *Achrouteria*, for example, with fruits like those of *Achras* and flowers like those of *Pouteria*. It seemed, therefore, at first sight, no easy task to give the genus *Nesoluma* its proper place in the system of the order as previously published (13, pp. 10-12; 14, pp. 382-385; 15, pp. 549-551).

As is illustrated by the generic synonyms *Palaquium* (*P. Nadeaudi*) and *Chrysophyllum* (*C. polynesicum*), the choice was mainly between the groups with whorled sepals (Palaquieae, Madhuceae) on the one hand, and those with spirally arranged sepals (Chrysophyllinae, Sideroxylinae.) on the other.

Moreover, the genus shows a considerable variability in almost every character, which further complicates the classification. How-

[3] A single example of a 2-seeded fruit is mentioned by Hillebrand (12).
[4] Numbers in parentheses refer to Literature Cited, p. 157.

ever, anyone acquainted with the natural order of the Sapotaceae will not be led astray by the calyx being frequently *Madhuca*-like and the number of petals being often more or less twice that of the sepals. He will intuitively know, as did L. Pierre, whose numerous annotations on the Paris sheets it was my fortune to use and to admire, that *Nesoluma* is undoubtedly a member of one of the groups with spirally arranged sepals.

In attempting to place *Nesoluma* in the system of the Sapotaceae, I will now discuss its more prominent features. In comparing *Nesoluma* with other genera and species, I used not only the material extant in the National Herbarium, Leyden, and the literature mentioned at the end of this paper, but also the splendid and valuable set of drawings of Sapotaceae made for L. Pierre by E. Delpy in 1891-1904, and preserved in the Paris Herbarium. Most, or possibly all, of these are unpublished and I am very much indebted to Professor Humbert, Director of the Paris Herbarium, for permission to study these drawings which were most valuable to me in gaining an insight into the systematic relations of *Nesoluma*.

VEGETATIVE PARTS

(Figs. 1-8, 10, 80, 81, 103)

Usually the vegetative parts do not provide generically important features. In the Sapotaceae, however, the nervation of the leaves may be an important generic character (Madhuceae) and the same may be true, although to a lesser degree, for *Nesoluma*. Its reticulation is very characteristic, being mostly extremely minute and areolate (figs. 81, 103) and though in some specimens of *N. polynesicum* (fig. 10) the areoles are more longitudinally stretched (both types may be seen in the same specimen and even in the same leaf), it may be called characteristic for the whole genus. The same type of reticulation is found in several species of *Sideroxylon* (*Calvaria*) and *Lucuma* (*Pouteria*). Particularly the resemblance both in shape and in reticulation with the leaves of *Calvaria inermis* (*Sideroxylon inerme*) (south and southeast Africa) is striking (5; 8, Taf. 7).

INFLORESCENCES

These show no special features that are not inherent to the natural order as a whole.

CALYX

There are usually 4 sepals, but 5 sepals are not rare. When there are 5 sepals the arrangement is spiral and of the ordinary Sideroxylinae type. As the 4-merous calyx is almost always more or less irregular (figs. 11, 14, 42-45, 59, 82)—the outer sepals are usually smaller than the inner ones, unequal in size, and not strictly opposite (cf. *Leptostylis*)—I consider the 5-merous calyx as the basic or at least the original type, of which those with 4, 6, or 3

sepals (given in the order of frequency observed) are variations or derivations. Out of 30 flowers of all species, only one calyx was 3-merous, 20 were 4-merous, 7 were 5-merous, and 2 were 6-merous. In this variability, as in that of other whorls, both a serial and a collateral contraction or duplication seem to play a certain part; in some specimens two sepals are inserted opposite each other (figs. 15, 44, 87), in others two smaller and much imbricate ones seem to take the place of one large sepal (figs. 12, 13, 70). This phenomenon is still more obvious in the corolla. Only one specimen examined had part of an inner sepal petaloid (*N. polynesicum*, St. John 10124, ♀ flower).

COROLLA AND ANDROECEUM

More than in any other genus of the Sapotaceae with which I am familiar, there is a strong correlation between the corolla and the androeceum. With the abortion of the male organs in unisexual (female) flowers [cf. *Planchonella obovata* (13, p. 213, fig. 58), *firma,* and *petaloides* (13, p. 196, fig. 53), certain *Sideroxylon* and *Pouteria* species, *Ecclinusa, Omphalocarpum* (8, Taf. 1, 4, 5), etc.], which seems to be a feature of certain individual trees, there is generally also reduction of the corolla to leave only a number of small scales at the foot of the ovary. In addition, the flower may often contain peculiar structures that have been called "staminodes", with obvious and justified doubt (by L. Pierre in his unpublished notes). These organs (figs. 22, 23, 33, 36, 39, 40, 47, 48, 52-57, 104, 107) may be inserted either between and inside two petals (figs. 19, 39, 70) where they may be compared with true staminodes, such as are known in *Sideroxylon, Planchonella, Pouteria,* etc., or they may be inserted opposite a petal, evidently taking the place of a stamen, where they show transitions toward what undoubtedly are sterile stamens (figs. 47, 54-56, 90, 91, 107). On the other hand, they may represent a petal, as appears from their shape as well as from their position and their bearing a stamen (figs. 35, 36, 40, 52, 53). The same phenomena of contraction and, here especially, of duplication[5], mentioned for the calyx, are strikingly apparent in the corolla and the androeceum; and *Nesoluma* shows all transitional organs in the series shown in figure 33. In this connection it is important to note that the petaloid "staminodes" and the scaly petals (fig. 33, *d, f*) are often more or less conspicuously 3-dentate (staminodes: figs. 23, 47, 52-57, 104; petals: figs. 63, 65, 66, 73, 74, 102), as are the staminodes of such species as *Planchonella obovata* (13, p. 213, fig. 58), *Krausella Schlechteri* (15, tab. 128), many species of *Omphalocarpum* (8, Taf. 2-6), etc. I mention this point because the so-called "staminodes" of the Sideroxylinae have heretofore usually been interpreted as representing a whorl of sterile stamens, apparently on account of the continuous alternation of the consecutive whorls in the flower. Now that we know *Nesoluma* better, however, they may as well be considered as a whorl of reduced petals.

This problem is worth studying more thoroughly, as there is still another question connected with it. Eichler (6, p. 333) and, probably on his authority, also Hartog (13, p. 8) consider the smaller "staminodes" of *Bumelia, Dipholis,* etc. (with a whorl of larger alternipetalous staminodes, and two smaller structures next to each petal), and also of the Mimusopeae, as "Nebenblättchen an den Kronenlappen." This interpretation seems to be supported indeed by the more or less lateral position of the staminodes (ventral in *Bumelia* and *Dipholis,* dorsal in *Mimusops* and *Manilkara*). However, these corollary "stipules" may

[5] Duplication may be merely an atavistic form and thus a primitive phase of the tendency of contraction in the flower.

southeast Africa, Madagascar, and the Mascarenes has convinced me that the two genera are very closely related. The resemblance is based upon such points as:

1. One-seeded fruit
2. Pericarp with abundant and viscid milky juice
3. More or less globular seed
4. Faint ribs on testa [*Nesoluma Nadeaudi, Sideroxylon* (*Calvaria*) *inerme*]
5. Basal seed scar
6. Thick and bony testa
7. Testa veined inside
8. Abundant albumen
9. Tangential and oblique or horizontal position of the embryo

The size of the seed scar of *Nesoluma* is intermediate between the large basal scar of some *Calvaria* species from Madagascar and Réunion (11), and the scar of such species as *Sideroxylon inerme* L. [*Calvaria inermis* (L.) Dub.; see 5] and *S. diospyroides* from south and southeast Africa (8, Taf. 7).

FLORAL FORMULAE

In order to illustrate the above conditions I give here a statement of the structures found in some of the flowers examined. (See also the diagrams in figs. 12-16, 18-20, 34-35, 44-45, 60, 70, 84-87, 95-96, 108.)

RELATIONSHIP

Summarizing and completing our survey, we may say that *Nesoluma* combines features of the following groups and genera:

Leaf type and reticulation: *Sideroxylon* (*Calvaria*) *inerme* and *diospyroides, Sebertia, Lucuma Lecomtei* Guill., and *L. neocaledonica* Engl.

Unisexual flowers: *Ecclinusa*, certain *Planchonella* species (*P. obovata, P. firma, P. petaloides*), certain *Sideroxylon* and *Pouteria* species, *Omphalocarpum*, etc.

Calyx: *Leptostylis*, certain *Pouteria* species.

Pleiomery of androeceum: *Pycnandra, Achradotypus, Omphalocarpum*, many Madhuceae.

Pleiomery of corolla and androeceum: *Ochrothallus, Leptostylis, Krausella*, certain *Planchonella* and *Pouteria* species.

Reflexed filaments: *Calvaria* sensu lat. (in the sense of Dubard, 5), *Leptostylis, Ochrothallus, Pycnandra, Pouteria ptychandra, Pouteria* sect. *Pradosia, Aulandra*, certain *Palaquium* species.

Staminodial structures: no staminodes in *Leptostylis, Pycnandra, Chrysophyllum*, staminodes sometimes reduced in certain species of *Planchonella* and *Pouteria*; shape or position: *Cryptogyne, Calvaria* sensu lat.

Gynophore: *Calvaria* sensu lat. (glabrous basal part of pistillum often extant), *Krausella* (in *Nesoluma*, if any, without a distinct disc).

Gynaeceum: *Sideroxylon, Planchonella*, and *Pouteria*, but often meiomerous as in some *Pouteria* species, *Burckella*, etc.

Ovule: *Leptostylis, Sideroxylon, Pycnandra, Mimusops, Northia.*

Fruit: *Calvaria* sensu lat.

Seed (testa): *Calvaria* sensu lat., *Northia fasciculata* (Warb.) H. J. Lam.

Embryo—plane of cotyledons: *Calvaria*, certain *Pouteria* and *Palaquium* species.

Flower Structure in Nesoluma Species

Species	Specimens	Number of Sepals	Number of Petals: Large	Number of Petals: Small	Number of Petals: "Staminodes"	Number of Petals: Total	Number of Stamens: Normal	Number of Stamens: Small	Number of Stamens: Total	Number of Carpels
N. polynesicum var. α, forma a	type sp. (P)	5	8	2	1	11	8	..	8	4
	" " "	5	6 (2 with adnate "staminodes")	...	4	10	8	2 (adnate to ovary)	10	?
	" " "	4	5	4	..	9	9 (2 connate and 1 adnate to ovary)	3	11	?
	" " (B)	4	8	..	1	9	9	..	9	4
	" " "	3	8	..	1	9	8	..	8	3
	" " "	4	6	3	..	9	9	..	9	4
	Munro 955 ♀	4	..	3	..	3	..	..	..	5
	Forbes 503	5	?	?	?	?	10	..	10	3
	" " (fig. 35)	6	3+2×2	..	1	8	6	5	11	3
	Forbes 503	4	4	4	..	8	7	..	7	3
	Munro 111	4	5	..	..	5	6	..	6	5
	" " (fig. 38)	4	4+ (2)	..	2	8	7	..	7	6
	Munro 111	4	6	..	1	7	6	1	7	4
N. polynesicum var. β forma a subf. 2	Forbes 11596 ♀	4	..	7	..	7	..	..	..	4
	" " ♀	4	.	8	..	8	..	..	..	4
N. polynesicum var. β forma b	St. John 10124 ♀	4 (1 half peta-	..	7	..	7	..	..	..	3

	Brown and Judd 1307 (fig. 70)	6	6	4	2 (1 adnate to large petal)	12	9	..	9	2
	" "	5	4	5	1	10	11	..	11	4
	McEld. and Skottsb. 369 ♀	4	..	x (irregularly dentate)	..	x	..	..	..	5 (2 sterile)
N. St.-Johnianum	St. John and Fosb. 15105 ♀	4		3	.	3	.	..	..	4
	" " ♀	4	.	4		4	..	..	..	4
	" " ♀	4		5	.	5	..	..	..	4
	" " ♀	4		8	.	8	..	..	..	5
	" " ♀	4		8		8	..	..	..	4
	" " ♀	4	4	..	..	4	8	..	8	4
	St. John and Fosb. 15137	5	8	..		8	8	..	8	4
	" "	4	3	5		8	9	1	10	5
	" "	5	4	4	1	9	8	..	..	3?
							8 (2 connate)			
N. Nadeaudi	from MS. notes by L. Pierre	5	5-6	5-6	see under stamens	10-12	9-12 (staminodes incl.)			4-6

Systematic Position of the Genus Nesoluma

As far as I know, only two authors have expressed their opinion on the systematic position of *Nesoluma*; Engler considered it, probably on account of the absence of staminodes, as a section of *Chrysophyllum* (see p. 129), which genus has always been a sort of repository for species of doubtful position in the Sapotaceae; Baillon (1, p. 279) inserted it in his Buméliées (= Sideroxylinae Engl.) between *Sarcosperma* (which I consider to represent a separate order; see Blumea, vol. 3, p. 183, 1938) and *Sersalisia.* Although he does not mention it definitely, and staminodes are not quoted in his over-simplified description, he apparently means to include *Nesoluma* in the subtribe Eubuméliées, characterized by alternipetalous staminodes and subbasal seed scar (1, p. 271).

Most of the more recent authors have maintained *Nesoluma* as an insertion in *Chrysophyllum.* This all concerns *"Chrysophyllum" polynesicum,* the only species known up to the present, and known only from the Hawaiian islands. A second species discovered by Nadeaud in Tahiti, was described with doubt as a *Palaquium* (*P. Nadeaudi*=*Nesoluma Nadeaudi*). Its generic identity with *Nesoluma* was stated afterward by Pierre but never published. Now that we know the genus far better and its morphology almost completely, we have to reconsider the systematic position of the genus.

Referring to my earlier publication on the Sapotaceae (13, pp. 8-12), it must be stated, in the light of modern knowledge and particularly in view of the primitive characters revealed in *Nesoluma,* (1) that Baillon's order of succession of the tribes should be preferred to that of other authors, insofar as he puts the tribe with spiral arrangement in the flower first; and (2) that the Chrysophylleae—as a tribe or as a subtribe—must be dropped, since *Nesoluma* may or may not possess the alternipetalous staminodes, which is the criterion of this group.

Consequently I would here propose a tentative alteration of my earlier system of the family; in this scheme the Sideroxylinae are put first, since they must be considered as the tribe with apparently the greatest number of primitive features (spiral arrangement of sepals). Only the Achradidae among this tribe have attained a cyclical arrangement of their sepals.

From the Sideroxylinae may be derived on one hand the Mimusopinae, and on the other (through *Diploknema* and *Aesandra*) the Palaquiinae. The Mimusopinae is a new tribe; it seemed preferable to give the former Mimusopeae that rank, although the definite distinction of this group by the dorsal appendages at the petals is recently blurred by the discovery of *Northia* species in which these appendages are much reduced or even wanting. Although each of the three tribes has its primitive and its secondary characters, the Palaquieae and the Mimusopeae seem to represent slightly younger groups, as the cyclic arrangement in the calyx is generally attained in them. In order to show the connection with the Sideroxylinae as regards the "stipular" appendanges to the petals, the Mimusopinae are put in the second place and therefore the Palaquiinae last.

The subdivision of the tribes, Mimusopinae and Palaquiinae involved no special difficulties. The usual subdivision of the Sideroxylinae, however, is based upon the position of the hilum of the seed. When the hilum is basal (Sideroxyleae Dub.) the scar is small and circular and the hilum is situated quite close to the micropyle. When the hilum is lateral to apical (Lucumeae Baill.) the scar is long and narrow or occupies a large part of the testa. In both groups the embryo takes a vertical position. There are some intermediate cases relative to the scar character, which may be a valuable one as it plays also an important part in the subdivision of the Mimusopinae. *Nesoluma* and *Calvaria* (1, p. 258, figs. 274-275; 8, Taf. 7; 11) from south and southeast Africa, Madagascar, and the Mascarenes, take an intermediate position in this respect, insofar as they possess either a large, circular, basal or subbasal scar in which the hilum is not situated very near the micropyle, or a small, circular, basal scar; in both cases the embryo is oblique or horizontal. I agree with Dubard (5, pp. 84-88) that the genus *Calvaria* Commers. must be kept separate from *Sideroxylon,* as it is not only characterized by its basal seed scar but particularly by the horizontal position of the embryo, and also by the characteristic reticulation of the leaves, the petaloid "staminodes" and the albuminous seed. I am inclined, therefore, to accept Dubard's inclusion of such species as *Sideroxylon inerme* L. and *S. diospyroides* Bak. in *Calvaria,* in which the embryo takes a horizontal position, although the seed scar is small, as in the true Sideroxylons. I am not able to check all other species mentioned

under *Calvaria* by Dubard, but I am inclined to accept provisionally his delimitation of the genus. The species from the Mascarenes, Madagascar, and south Africa are of the greatest importance in connection with my ideas on the Antarctic origin of the Calvarieae, a new subtribe comprising the genera *Nesoluma* and *Calvaria* (see below).

New Subdivision of the Sapotaceae

My new tentative scheme is as follows:

Tribe I. Sideroxylinae Engl. (including Chrysophyllinae Engl.).

Sepals spirally arranged and calyx 5-8(-12)-merous or with two whorls of 2, 3 or 4 sepals (if 2, then the sepals sometimes unequal and not strictly opposite); corolla isomerous or rarely pleiomerous (*Nesoluma, Chrysophyllum*); stamens epipetalous and often insomerous with petals, sometimes more (*Nesoluma*, Achradotypeae), in one whorl; alternipetalous staminodes often extant, more rarely none; carpels usually isomerous with the calyx, rarely less, even more rarely more (*Pycnandra*); petals sometimes with ventral or lateral appendages (*Bumelia, Dipholis*) but never with dorsal appendages. Circumtropic.

Subtribe A. Calvarieae, nov. subtr.

Seminis albuminosi subglobosi cicatrix (magna vel parva) orbiculata vel suborbiculata, basalis vel sublateralis. Testa ossea. Embryo tangentiali-obliquum vel plus minusve horizontale. Foliorum reticulatione perminute areolata. Staminodia, si adsunt, plerumque magna vel petaloidea.

Key to the Calvarieae

a. Calyx usually 4-5-merous, petals and stamens 8-12, carpels usually 3-5; no regular alternipetalous staminodes extant (Polynesia) .... **Nesoluma** H. Baill.

aa. Flowers 5-merous in all whorls; alternipetalous staminodes extant (south and southeast Africa, Madagascar, Mascarenes) .... **Calvaria** Commers.

Subtribe B. Sideroxyleae Dub. sensu stricto (= Eusideroxyleae Dub.).

Hilum basal, close to the micropyle; scar of the testa small and circular, basal. Not in Malaysia or Polynesia. (*Bumelia* Sw., *Dipholis* A.DC., *Sideroxylon* L., *Argania* Roem. and Schult.)

Subtribe C. Pouterieae (9, pp. 159-163), nov. nom. (Lucumeae Baill.).

Hilum lateral or apical, distant from the micropyle; scar of the testa long and narrow or occupying a considerable part of it.

Section 1. Eupouterieae, nov. nom. (= Eulucumeae H. J. Lam).

Stamens as many as petals or at most less than twice their number.

Subsection a. Planchonellidae, nov. subsect.

Sepala spiraliter inserta, interdum biserialia vel subbiserialia (2+2). Circumtropic.

Key to the Planchonellidae of the Pacific

a. Calyx 4-5-, corolla 4-6-merous; gynophore none; disc often extant,
  b. Alternipetalous staminodes extant (in *Pouteria* rarely none); disc often extant,
    c. Albumen usually abundant, cotyledons foliaceous; fruit relatively small, often pointed, pericarp thin, rarely larger, globose and fleshy; sepals always 5, petals 5, exceptionally 6; carpels 5 (tropical Asia to Polynesia)..**Planchonella** Pierre.
    cc. Albumen usually none, rarely somewhat extant, cotyledons fleshy; fruit often large, usually globular, pericarp fleshy; sepals 4-5, petals 4-6, carpels 1-12 (tropical America, Polynesia, Australia, Malaysia, Malay Peninsula, and India)............**Pouteria** Aubl.[6]
  bb. Staminodes and disc none.
    d. Corolla tube shorter than the lobes; sepals usually 5, sometimes 6-7-11; ovary 5-10-11-celled (tropics)........................**Chrysophyllum** L.[7]
    dd. Corolla tube much longer than the lobes, sepals 4; ovary 4-celled (New Caledonia)..**Leptostylis** Benth.
aa. Calyx and corolla 6-8-merous; gynophore and disc extant (New Guinea)..**Krausella** H. J. Lam

In this subsection (Planchonellidae) are probably also *Sebertia* (New Caledonia, insufficiently known to me), *Micropholis* Griseb. (tropical America and Angola), *Achrouteria* Eyma (Guiana), *Calocarpum* Pierre (tropical America), and *Bakeriella* Dub. (tropical Africa), etc.

Subsection b. Achradidae, nov. subsect.

Sepala biserialia (3+3: *Achras* L., tropical America; 4+4: *Butyrospermum* Kotschy, tropical Africa); staminodia staminaque sepalis isomera (tropical America and Africa).

Section 2. Achradotypeae H. J. Lam.

Stamens 2 or more opposite each petal. (*Achradotypus* Baill., New Caledonia and New Guinea; *Omphalocarpum,* tropical Africa; *Pycnandra,* New Caledonia.)

Tribe II. Mimusopinae, nom. nov. (=Mimusopeae Hartog).

Petals with dorsal or dorso-lateral appendages (rarely abortive); calyx, corolla, stamens, and staminodes isomerous. Circumtropic.

Subtribe A. Mimusopeae, nom. nov. (=Eumimusopeae Dub.).

Hilum basal, close to the micropyle; scar of the testa small, circular, basal; flowers 8-merous (*Mimusops* L., etc.).

Subtribe B. Manilkareae Dub.

Hilum apical or lateral, distant from the micropyle; scar of the testa linear and narrow [*Manilkara* (Rheede) Adanson, appendages and staminodes large] or broad and large (*Northia* Hooker f., appendages and staminodes small, rarely abortive); flowers 6-merous.

Tribe III. Palaquiinae Dub.

Calyx with two fully cyclical whorls of 3 or 2 sepals, rarely 5 spirally arranged sepals (*Diploknema*); stamens twice as many as petals or more,

[6] Including *Lucuma* Molina (9, p. 159, descr. emend.). There is no sharp distinction between *Pouteria* and *Planchonella*. Both are large genera and *Pouteria* is probably the more primitive.

[7] Apparently a heterogeneous genus, urgently wanting revision; including *Ochrothallus* (which is probably better considered as a separate genus) and *Trouettia*.

rarely less, in two or more whorls; staminodes none (sterile stamens exceptionally extant); petals without dorsal appendages. South and eastern Asia to Australia and Polynesia.

Subtribe A. Madhuceae H. J. Lam.

Petals and carpels more numerous than sepals, usually twice as many, the carpels rarely less (*Burckella*); sepals cyclically or spirally arranged.

Section 1. Diploknemeae H. J. Lam.

Sepals (4-)5, spirally arranged, petals (8-)12, stamens 10-40 in 2-4 whorls, carpels 5-12 (*Diploknema* Pierre, *Aesandra* Pierre).

Section 2. Eumadhuceae H. J. Lam.

Sepals in two dimerous whorls (*Burckella* Pierre, *Ganua* Pierre, *Payena* DC., *Madhuca* Gmel.).

Subtribe B. Palaquieae Engl.

Calyx, corolla, and gynaeceum normally isomerous; calyx whorls fully cyclical (trimerous in *Palaquium* Blanco and *Aulandra* H. J. Lam, usually dimerous in *Isonandra* Wight).

Phylogeny

The survey of the relationship of *Nesoluma* (p. 136) indicates that the more important connections and relationships seem to be particularly with genera from:

1. South and southeast Africa, Madagascar and the Mascarenes (*Calvaria* sensu lat.: leaves, androeceum, testa of seed, embryo!; including *Cryptogyne*: stamens!).
2. New Caledonia (*Sebertia*: leaves; *Lucuma*: leaves; *Leptostylis*: calyx, filaments; *Achradotypus* and *Pycnandra*: androeceum; *Ochrothallus*: pleiomery of corolla and androeceum).
3. New Guinea (*Northia fasciculata*: testa of seed; *Achradotypus*: androeceum; *Krausella*: gynophore).

One of the most striking facts of this statement, it seems to me, is the closeness of relation with south and southeast Africa, Madagascar, the Mascarenes, and to a certain degree also with New Caledonia. Other relationships seem much less significant.

I have already stated (p. 138) the striking resemblance of *Nesoluma* particularly with such species as *Calvaria inermis* (L.) Dub., etc., and I do not think it is too speculative to suggest that the ancestors of the Calvarieae have lived in the Antarctic continent. Among them *Nesoluma* has certainly preserved the greatest number of primitive features such as the instability in the number of whorl parts, concerning which *Calvaria* is already fixed (5-merous throughout). While *Nesoluma* is therefore to be considered as the most primitive genus of its tribe and, consequently, of the whole order, I would suggest that from these extinct Procalvarieae in the Tertiary Ant-

arctic continent, two lines of evolution have survived. One of them has developed into the group with small basilateral seed scar (Sideroxyleae), first with albumen (*Sideroxylon, Argania, Dipholis*), afterward exalbuminous (*Bumelia*); the other has developed into the groups with long and narrow or with very large seed scar (Pouterieae). During this evolutionary process migrations took place along various lines of dispersal. *Nesoluma* maintained itself as a relic in the central part of the Pacific and has, apparently on the basis of a rather rich potential polymorphy, developed a number of closely related forms in various parts of its vast relic area. *Calvaria,* younger and more specialized than *Nesoluma,* has its center in south Africa and the Mascarenes. Such habitats as Cape Verde, Madeira, and Socotra have to be checked; perhaps they are outposts, but more probably they are relics from a formerly larger generic area. This is the more probable as *Sideroxylon,* representing a further phase, has also a disjunct area [according to Dubard(5) : Antilles, Hong Kong, Tonkin, Abyssinia] which can be best explained as a relic area, with which the areas of *Argania* (Morocco) and of *Dipholis* (Antilles) closely agree. The areas of the younger groups need not be mentioned here. Suffice it to state that I consider *Nesoluma* as an Antarctic relic.

Similar conditions are found in other genera, such as *Astelia* (22, p. 3323), that are generally considered as Antarctic relics. The source must be sought in the Tertiary Antarctic continent, which has repeatedly been claimed by such investigators as Setchell (19,20) and Skottsberg (21,22,23) as the rich reservoir of floral elements from which the floras of the Southern Hemisphere have been fed. Skottsberg's maps of the area of *Astelia* (22, pp. 3318, 3323; 23, p. 295) and its sections are particularly interesting in studying the area of the Calvarieae, because the Mascarenes, New Caledonia, Tahiti, and Hawaii are included in the generic area of *Astelia.* The concordance between *Astelia* and *Nesoluma,* however, is not far-reaching, both because the area of *Nesoluma* is much smaller and because *Astelia* is a plant of the high mountains, *Nesoluma* a native of tropical or subtropical foothills (from near the seashore up to about 800 m., as far as my data go). Also *Astelia* consists of a number of species that are not closely related, while *Nesoluma* seems to form one large intercrossing population. Both, however, show no particular adaptations to dispersal; I suppose, at least, that the very thin pericarp of the *Neso-*

luma fruits forms no alluring food for birds; winds and sea currents are still less probable means of dispersal.

There are several other indications of connections between the Mascarenes and Polynesia. Skottsberg mentions several species which are important in this light. One of them is an *Acacia* species close to *A. Koa* (21, p. 15); others are *Sophora*, sect. *Edwardsia* (23, pp. 297-298), *Vincentia* (23, p. 298), and *Weinmannia* (23, pp. 298-299). All these species are taken from what Skottsberg (23, p. 292) calls the tricentric group, which comprises systematic units represented in Africa, America, and Australasia. Thus far we have mentioned examples in which the African sector was represented only by Madagascar and the Mascarenes. When the continent is also taken into account, such genera as *Gunnera* and *Acaena* become important in comparison with *Nesoluma*. We must, however, remember that we lack in *Nesoluma* the knowledge of actual habitats outside the central Pacific and that we have to rely upon supposed, though close, relations instead of actual habitats. The phylogeny of *Nesoluma* is therefore more speculative and more uncertain than that of the other genera mentioned.

Subdivision and Geographic Distribution of the Genus Nesoluma

The specimens of the genus available for investigation show strong variability in many of the characters, a peculiarity of a young group in active evolution. This is strange as the group seems very well circumscript as a genus. Its generic characters—in spite of their instability (which is a generic character itself)—preclude any confusion with other genera; the specific and still smaller features show the same entangling network of always repeated combinations which is so characteristic for the whole order. Most striking generic features are: the flower-characters (particularly their instability), the one-seeded fruit and the quite peculiar seed (large basilateral to basal scar, bony testa, tangential and oblique position of embryo), and to a certain degree also the reticulation of the lower side of the leaves. Features of lesser rank are the drying color (light yellowish green to dark brown); the shape and the dimensions of the leaves; the pubescence of branchlets, leaves, and flowers; the dimensions of the pedicels and the flowers; the number of flowers in the inflorescences; the

unisexuality of the flowers; the extant or non-extant gynophore; the shape and the dimensions of the fruit; and the more or less fully anatropous ovules and the therefore more or less basal position of the seed scar. Several of these features could not be checked in many of the specimens, and therefore they were less appropriate as the basis of a subdivision; many other features supplied no taxonomic constancy and only a slight geographic correlation (see p. 148).

I applied various methods in arranging the various features (cf. 18, pp. 180-184) but none gave a satisfactory result and I was forced to conclude that intercrossing must be as frequent in this genus as it is supposed to be in *Gouldia* (Rubiaceae) (10, pp. 10-12), which occupies a much smaller area than *Nesoluma*. The geographic area of *Nesoluma* is entirely situated in the central Pacific, extending over almost 50 degrees of latitude (or more than 6,500 km.) from Hawaii to Henderson Island and Rapa. Exactly the same form (*N. polynesicum,* var. β, forma a, subf. 1) has been collected both in Hawaii and in the Austral Islands (Raivavae and Rapa). The distinguishing of three different species, then, is to be considered as a provisional scheme; I expect that the study of more material will lead to the combination of these species into one large "linneon."

The main species, *N. polynesicum,* occupies by far the largest area and contains numerous forms. It occurs abundantly in the Hawaiian islands (Oahu, Lanai, Molokai, Maui) and has also been collected (variety β only) in the Austral Islands, a remarkable disjunction that may perhaps be filled in by future collections. Maybe, however, the disjunction in the area of *Nesoluma* really exists. I would, incidentally, suggest that a solution of this problem could then be sought in the geologic history of the Pacific as suggested by Chubb [cited in 24, p. 511 (Geol. Mag. **71**: 300, 1934)].

The two species which I provisionally separate from the main species, partly on geographic grounds, are *Nesoluma St.-Johnianum* from Henderson Island and *N. Nadeaudi* from Tahiti. These two species agree in that they are large-leaved, while the typical *N. polynesicum* is small-leaved (the large-leaved forms of the latter species are in other features discordant to *N. St.-Johnianum* and *N. Nadeaudi*). *N. Nadeaudi* is insufficiently known. It seems to be distinguished also by a relatively large fruit. None of the species can be said to represent a more primitive form than either of the other two.

SPECIES OF NESOLUMA

Key to the Species of Nesoluma

1. a. Leaves generally small and elliptic or ovate or slightly obovate with more or less broadly cuneate or subrotundate base and rounded apex, pubescent or not when young, brown or more rarely somewhat greenish yellow when dry; shape, size, and pubescence of leaves extremely variable, from oblanceolate to ovate and broadly elliptic, generally about 4-8 cm. long and 2-4.5 cm. broad, if up to 12 cm. long then 4-6.5 cm. broad, and with rounded apex; reticulation variable, minutely areolate to more irregularly reticulate; fruit 1-1.5 cm. long, about 1 cm. in diameter (Hawaii and Austral Islands) .... 1. **N. polynesicum**
   b. Leaves larger, oblong-ovate to oblong, narrowing toward the apex, which is blunt, generally 6-13(-16) cm. long, 3-5.5 cm. broad; reticulation minutely areolate, areoles circular; fruit 1.5-2.5 cm. long (Henderson Island, Tahiti) 2
2. a. Leaves oblong-ovate to oblong, light yellowish green when dry (always?), petioles 1.5-2.5 cm. long; fruit 1.5-1.9 cm. long, 0.7-1 cm. in diameter (Henderson Island) .... 2. **N. St.-Johnianum**
   b. Leaves ovate to elliptic-ovate, dark brown when dry (always?), petioles 2-4 cm. long; fruit 2.5 cm. long, 1.7 cm. in diameter (Tahiti) .... 3. **N. Nadeaudi**

1. Nesoluma polynesicum (Hillebr.) H. Baill., Soc. Linn. Paris, Bull. 2: 964, 1891; Hist. d. Pl. **11**: 279, 1892 (nomen in annot.). Type species (pls. 1-3, figs. 1-79).

Chrysophyllum polynesicum Hillebr.: Flora Hawaiian Is., 277, 1888.

A small tree or large shrub, up to 7 m. high and 20 cm. in diameter, with milky juice, bark rough, brown or gray, sapwood creamy. Branchlets round, up to 0.5 cm. thick, often slender and rather smooth, or wrinkled when dry, the ultimate tips ferruginously tomentose. Leaves variable in size, shape, and pubescence, generally elliptic or ovate, sometimes somewhat obovate, rarely oblanceolate, base usually broadly acute to subrotundate, rarely cuneate, apex broadly rounded, more rarely gradually narrowing and obtuse, margins entire. Blade and petiole mostly dark brown when dry, sometimes lighter brown or greenish brown, more rarely light greenish yellow. Leaves usually thin coriaceous and rather rigid, ferruginously pubescent on either side when very young, this pubescence remaining a longer or shorter time with age especially on the lower side. Midrib prominent below; secondary nerves 7-10-15, very faint and almost inconspicuous below, almost straight, ascending from the midrib at an angle of about 60-70 degrees, united near the margin in an irregular, thin, intramarginal nerve; tertiary nerves of variable type (even in the same leaf), minutely reticulate with a general parallelism to the secondary nerves, with subsequent grades to regularly areolate with circular and very conspicuous areoles. Dimensions of the adult leaves: (1-)4-8(-12.5) cm. long, (0.6-)2-4.5(-6.5) cm. wide, the petioles (1-)2-3(-5) cm. long. Inflorescences 1-5-flowered, with minute bracts which are ferruginously tomentose, fascicled in the axils of the leaves or of their scars, in the latter case in some forms borne upon mammillose dwarf shoots on the older parts of the branchlets. Pedicels

ferruginously pubescent or glabrate, (0.15-)0.4-0.6(-0.8) cm. long. Flower buds ovoid or globose in bisexual flowers, narrower and pointed in pistillate flowers with the style often slightly exserted. Open flowers with spreading corolla, apparently ephemerous, whitish or greenish white, with heavy, sweet odor. Calyx pubescent, glabrate or glabrous, except the very tips of the (outer) sepals, glabrous inside, 0.3-0.5 cm. long; sepals (3-)4-5(-6), spirally arranged and imbricate, if 4 then sometimes seemingly forming two dimerous whorls but usually the sepals of one whorl not strictly opposite and (especially the outer ones) unequal in size, the larger ones 0.3-0.4 cm. long and ovate, the smaller ones deltoid. In ⚥ flowers corolla glabrous except sometimes at the insertion of the stamens, with thin veined lobes and thicker, very short tube, the lobes somewhat exserted from the calyx but spreading just before falling off, about 0.3-0.4 cm. long. Petals or petaloid structures ("staminodes" inclusive) imbricate, variable in number and in shape, (5-)7-9(-12), usually the corolla consisting of 6-8 larger ovate and rounded petals and some smaller ones; smaller petals may be inserted either outside the larger sepals and are then usually smaller than these but of the same shape, or inside, and are then either long but narrow (particularly the blunt upper half) or small and then more or less dentate, 3-lobed or fimbriate and with an acute apex. The smaller petals have no definite position and show transition forms to the stamens, in shape as well as in position, and may therefore often recall the alternipetalous "staminodes" of other genera of the Sideroxylinae. Insertion of the petals rather variable on account of the apparently frequent collateral or serial duplication, which is also found in the androeceum. Connations among petals (bifid or bilobed petals) and between petals and "staminodes" are rather frequent. Tube very short, thick because of the adnation of the filaments. In ♀ flowers corolla much reduced to a variable number of tiny scales (1-8) being either free at base or connate into a very short tube, these scales either entire and subulate (petaloid) or irregularly dentate (staminodioid), inserted at or around the base of the ovary. Androeceum closely correlated with the corolla in such processes as duplication and insertion; fertile stamens (6-)8-10(-11), often unequal in maturity, some of them already with opened sacs, others still very young, sometimes some of them sterile, with transitions to the "staminodioid" petals; insertion more or less irregular, sometimes equally distributed, sometimes sectorially somewhat crowded, 1-3 opposite a petal. Normal stamens glabrous or the filaments slightly woolly, filaments stout, subulate and usually flattened and broader at base, adnate to the corolla tube at their base and outwardly reflexed even when ripe, stretched and then exserted and about 0.2-0.3 cm. long in fully open flowers, anthers oblong ovoid, the apex sometimes minutely bifid, 0.15-0.2 cm. long. Pistillum with appressed stiff hairs covering the ovary which is or is not borne upon a glabrous sterile part (gynophore) in which sometimes (on longitudinal sections) an adnate disc can be traced; fertile part slightly furrowed (2-)3-5(-6)-celled, the cells 1-ovuled (bi-ovulate cells are rarely found and are abnormal), ovules half to almost fully anatropous; ovary gradually narrowed into a stout glabrous style, the truncate stigma of which is usually not, sometimes slightly, exserted from the calyx, especially in pistillate flowers. Fruits on hardly or not elongate pedicels and on a persistent and spreading calyx about 0.5-0.7 cm. in diameter, usually solitary, sometimes 2 or 3 in the axils of the leaves or of their scars, glabrous, green when young, afterward turning brownish red and dark purple, black when dry, obovoid, sometimes short and almost globular with small abrupt beak (scar of the seed basal), sometimes narrower and elongate, with long and acutely pointed beak

(scar of the seed basilateral), (0.9-)1.2-1.4(-1.7) cm. long, (0.7-)0.9-1.1(-1.3) cm. in diameter, 1-seeded; seed somewhat shorter but with hardly smaller diameter than the fruit, namely 1-1.2 by 0.75-0.85 by 0.7-0.75 cm., the testa thick and bony, veined inside, shining brown without, except the scar which is roundish or elliptic and from almost fully basal to obliquely lateral; when obliquely lateral the seed is much narrower in its basal part. Embryo with copious albumen, plane tangential and oblique toward the flower axis; radicle inferior, not exserted.

A small tree in valleys, dry foothills, open slopes and dry forests from near the seacoast to about 1,500 ft. altitude, said to be good firewood (Rapa). Flowers and fruits have been collected in all months of the year. Native names: *Keahi* (Oahu, Lanai); *Kalaka* (Rapa).

Distribution: Hawaiian islands (Oahu, Molokai, Lanai, Maui), Austral Islands (Raivavae), and Rapa.

Subdivision of Nesoluma Polynesicum into Varieties and Forms

The subdivision of this polymorphous species must be provisional. Much more material than is available at the present is needed to get a satisfactory insight into the taxonomic and genetic structure of this "linneon", the constituents of which are probably interbreeding. Therefore, some or many of the forms described below may be only ephemerous and not taxonomically fixed. This is the reason why I did not add Latin descriptions to the forms and subforms. If, in spite of this instability, I have accepted two varieties, it does not mean that these varieties are undoubtedly geographically distinguished, though a certain geographical correlation of some of the groups cannot be denied (p. 148). The main subdivision has been based upon the pubescence of the leaves and the number of secondary nerves. I am aware of the fact that this is far from being a firm basis; neither is it a character which allows a positive identification of all specimens (cf. Forbes 112). All features, however, show a more or less continuous scale and I have the impression that there is a certain tendency to produce entirely glabrous forms in the southern area and pubescent forms in the northern area. The next feature to serve as a criterion would be the length of the petiole, but the pubescence of the leaves seems to be more in accordance with natural tendencies. Inflorescences, flowers, and fruits were absent in too many specimens to be used as a basis for subdivision; moreover they would probably not prove sufficiently stable.

CONSPECTUS OF THE SUBDIVISION OF N. POLYNESICUM

(For full particulars see pp. 148-153)

Plate 1, figures 1-9

Var. α typicum: adult leaves more or less pubescent, except the older ones; secondary nerves 7-10.
Hawaii (Oahu, Lanai, Molokai, Maui).

Forma a. genuinum: leaves small and broad (about 7 by 3.5 cm.), with short petioles (1.5-2.5 cm.).
Lanai, Molokai, Oahu.

Forma b. longipetiolatum: leaves small, with long petioles (2.5-4.5 cm.).
Lanai, Maui.

Subforma 1. originarium: leaves broad or narrow, pubescent, rigid.
Lanai, Maui.

Subforma 2. laurinum: leaves narrower, sooner glabrate, thinner, habit more slender.
Maui.

Forma c. microphyllum: leaves very small (up to 5 by 2 cm.), oblanceolate and crowded.
Maui.

Forma d. macrophyllum: leaves broadly elliptic to oblong, larger (up to 12.5 by 6.5 cm.).
Molokai, Lanai.

Var. β glabrum: adult leaves very soon glabrate; secondary nerves 9-15.
Hawaii, Austral Islands, and Rapa.

Forma a. genuinum: leaves shaped as in var. α, forma a.
Hawaii, Austral Islands, and Rapa.

Subforma 1. originarium: leaves larger, habit stouter, petioles up to 3 cm long.
Hawaii (Kauai, Oahu, Molokai), Austral Islands (Raivavae), and Rapa.

Subforma 2. gracilis: leaves smaller, habit more slender, petioles up to 2.3 cm. long.
Rapa.

Forma b. longipetiolatum: leaves larger, petioles longer (2-5 cm. long).
Hawaii (Oahu, Molokai).

ENUMERATION OF THE MATERIAL

Nesoluma polynesicum var. *α* **typicum** H. J. Lam, nov. var. (pl. 1, figs. 1-5; pl. 2).

Folia adulta praecipue subtus pubescentia, ultimatim vetustiora glabrata; nervi secundarii 7-10.

Adult leaves ferruginously pubescent, especially at lower side, the older ones ultimately glabrate; secondary nerves 7-10.

Forma **a. genuinum** (fig. 1).

Leaves small, ovate, elliptic or obovate with broadly rounded apex, dark brown when dry, with short petioles; blade (2.5-)6-8 cm. long, (1.2-)3-4(-6) cm. broad, petioles 1.5-2.5(-2.8) cm. long; inflorescences in the axils of the leaves, rarely more or less prominent, dwarf shoots extant.

Hawaiian islands: Lanai, July 1870, *Hillebrand* without number (B, P, L, US), type in Berlin Herb., with fruit and flowers; native name, *keahi*; "Lanai, *Kcahi* in convallibus Makaleha", [4 sepals, in one specimen 3 (out of 21)], small fragment with extensive annotations and figures by L. Pierre (P, *Pierre 6067*).

Molokai, Lanai, and Oahu, *Hillebrand* (B, G), fruit and flowers, [5 sepals, in two specimens 6 (out of 15)]. "Makaleha u. Wailupe auf Oahu," *Hillebrand* (B, K); another label in Berlin Herb. mentions Makaleha Valley, *Keahi,* with a Latin description, some fruits; probably Kew fragment is from this. "Mauna Loa auf Molokai," June 1870, *Hillebrand* (B), with fruit.

Hawaiian islands, Lanai: 1851-1855, *J. Remy 474* (P, L), 2 specimens with fruit in Paris Herb.; west end, dry forests, June 1913, *C. N. Forbes 153 L* (H, L, NY, US), with fruits and flower buds (seed scar very much lateral, fruit oblong and pointed); Paomai, dry forest, Aug. 1913, *G. C. Munro 31* (H, L), with fruits and some buds (probably ♀ tree; reticulation of leaves almost inconspicuous); Kaa desert, July 1910, *J. F. Rock 8671 a* (G), with fruits (fruits oblong and pointed; the number of the label was 8671, which had to be changed as 8671 is var. α forma b, subf. 1, from Maui); Kamao, alt. 1,500 feet, June 17, 1929, *G. C. Munro 955* (H), with fruits and flower buds (seed scar almost basal, fruit obovoid to globular, the only flower examined ♀, reticulation of leaves circular-areolate); Koele-Maunalei, July 1910, *J. F. Rock 8040?* (sic) (H), with fruits (fruit oblong and pointed, up to 1.7 cm. long, seed scar basilateral; leaves long remaining pubescent); another identical specimen, July 26, 1910, from windward open slopes of Lanai, bears the number *J. F. Rock 8040* (H, G, NY, US), with flowers.

Hawaiian islands, Molokai: Kaluakoi, Mauna Loa, on Puu Nana, alt. 200-400 m., March 10, 1930, *Krajina 126* (Kr, L), with fruits (pedicels exceptionally short, 0.15 cm. in flower, 0.3 cm. in fruit; fruit small and pointed, scar of the seed basilateral); Mauna Loa, June 1912, *C. N. Forbes 112 Mo.* (H, L), with fruits (transition form to var. β, forma a, subf. 1, inasmuch the leaves on some of the branchlets are very soon glabrous); no locality given, *H. Mann and W. T. Brigham 363* (H).

Forma **b. longipetiolatum.**

Leaves brown or somewhat greenish when dry, shape as in forma a or more obovate (the apex more narrowed), but petioles long and slender, 2.5-4.5 cm. long.

Subforma 1. **originarium** (fig. 2).

Leaves as in forma a, rigid, with rounded and relatively broad apex, sometimes narrower but with the venation, pubescence and general habit of forma a; inflorescences often on the older wood, on more or less prominent dwarf shoots in the axils of leaf scars.

Hawaiian islands, Lanai: Mahana, near Maunalei road, Sept. 22, 1913, *G. C. Munro 111* (H), with flowers and fruits; a second specimen without number but with identical label and with the addition, "Keahi", probably belongs here; west end, Sept. 1917, *C. N. Forbes 503 L.* (H), with flowers and 1 fruit (fruit oblong and pointed; flowers globular and relatively large, 0.5 cm. long, calyx 0.35 cm., flower parts very unstable; reticulation of the leaves very coarse).

Hawaiian islands, Maui: lava fields Auwahi, Nov. 1910, *J. F. Rock 8671* (H, G), with fruits (fruits obovoid, about 1.2-1.5 by 1-1.1 cm., seed scar almost basal; leaves narrower and more pointed and somewhat crowded toward the tips of the branchlets (cf. forma c; transition form to subf. 2).

Hawaiian islands: no locality given, 1913, *Wilder* (H), sterile.

Subforma 2. **laurinum** (fig. 3).

Leaves thinner and sooner glabrate, narrower with cuneate base and gradually narrowed apex with slender branchlets; inflorescences in the axils of leaves.

Hawaiian islands, Maui: Kamana, S. slope of Haleakala, March 23, 1920, *C. N. Forbes 2074 M.* (H, L), with young fruits (leaves light brown, soon glabrate; fruits obovoid).

Forma c. **microphyllum** (fig. 4).

Leaves oblanceolate, crowded at the tips of the branchlets, brown when dry, very small, 4-5 by 1.8-2.2 cm., petioles 1-1.5 cm. long; inflorescences not on prominent dwarf shoots.

Hawaiian islands, Maui: Olowalu Valley, May 9, 1920, *C. N. Forbes 2277 M.* (H, NY), with fruits (fruits obovoid, seed scar almost basal; leaves long remaining pubescent).

Forma d. **macrophyllum** (fig. 5).

Leaves large, elliptic or ovate to oblong, 8-12.5 by 4-6.5 cm., petioles 2-4 cm. long, blade yellowish brown when dry; inflorescences on prominent dwarf shoots.

Hawaiian islands, Molokai: Mauna Loa, April 1910, *J. F. Rock 7052* (H, G, NY), with young fruits (fruits obovoid); Mahana, April 1918, *J. F. Rock 14068* (H, US), with young fruits; same

locality, April 1909, *J. F. Rock* without number (G), with young fruits; same locality, March 1910, *J. F. Rock* without number (NY), with young fruits; Waiahewahewa Gulch, last relic of dry forest, April 18, 1928, *Otto Degener 10642* (NY), with young fruits.

Hawaiian islands, Lanai: *Hillebrand* without number (US), small specimen attached to a sheet of var. α, forma a.

Var. β **glabrum** H. J. Lam, nov. var. (pl. 1, figs. 6-9; pl. 3).

Folia adulta mox glaberrima; nervi secundarii (9-)10-15.
Adult leaves very soon entirely glabrous; secondary nerves (9-)10-15.

Forma **a. genuinum.**

Leaves shaped as in var. α forma a—small, ovate, elliptic or obovate with broadly rounded apex, about (1-)3-7(-9.5) by (0.6-)1-3.5(-5.3) cm., petioles 1-2.5(-3) cm. long, blade sometimes brown but often greenish when dry; inflorescences in the axils of the leaves or at least not on prominent dwarf shoots.

Subforma **1. originarium** (fig. 6).

Leaves brownish or greenish when dry, up to 9.5 cm. long and 5.3 cm. wide, petioles up to 3 cm. long.

Hawaiian islands, Oahu: Wailupe Valley, right hand branch, April 14, 1918, *J. F. Rock 17125* (H), with fruits (fruits obovoid to oblong ellipsoid); Honouliuli, Kaloi, in dry foothills, open country, alt. 300 m., May 10, 1937, *C. S. Judd 57* (H), with young fruits (small tree, 3.5 m.; fruits pointed); Waianae Mountains, southeast of Palehua, Nov. 23, 1935, *Otto Degener, Kwan Park and M. Takamoto 10108* (NY), with flower bud.

Hawaiian islands, Molokai: west Molokai, Mahana, March 1910, *J. F. Rock 12505* (H, NY), with fruits (fruits ovoid); same locality, April 1909, *J. F. Rock* without number (G), with fruits (fruits obovoid, up to 1.5 by 1 cm.).

Hawaiian islands, Kauai: Halemanu, near bottom of Waimea Canyon, Feb. 1907, *J. F. Rock 2336* (H), sterile.

Austral Islands, Raivavae: Pic Rouge, southwest ridge, patch of woods, alt. 170 m., Aug. 5, 1934, *H. St. John and F. R. Fosberg 15935* (H, L), (tree 6 m. high, 20 cm. in diameter; fruit green, sap milky); same locality, upper edge of forest, base of cliff, same date, *H. St. John and F. R. Fosberg 15936* (H, L), (tree 5 m. high, 20 cm. in diameter; flower whitish, perianth divergent, odor heavy, sweet; sap milky, bark rough, brown; sapwood creamy, streaked).

Rapa: Pake, mountain side, alt. 700 feet, Oct. 31, 1921, *A. M.*

Stokes 391 (H), with fruits (tree 14 ft., diameter 2 in., fruits turning brownish red, good firewood, native name *kalaka*; all fruits sterile, possibly an unfertilized ♀ tree?); same locality, Oct. 24, 1921, *A. M. Stokes 406* (H) (same annotations and remarks).

Subforma 2. **gracile** (fig. 7).

All parts more slender, leaves light green when dry, up to 7.2 cm. long and 3.3 cm. broad, petioles up to 2.3 cm. long.

Rapa: Hiri Valley, south slope of Morongota, alt. 175 m., dense forest, July 20, 1934, *F. R. Fosberg 11596* (H, L), with flowers (small tree 6 m. high; ♀ flowers only).

Forma **b. longipetiolatum** (figs. 8, 9).

Leaves brown or yellowish green when dry, larger and with longer petioles, 6.5-11.5 cm. long, 2.8-5.2 cm. broad, petioles 2-5 cm. long. Leaf shape rather variable, from broadly elliptic to oblong. Inflorescences often on prominent dwarf shoots.

Hawaiian islands, Oahu: Maunalua, Hahaione Valley, edge of pali, alt. 600 ft., Dec. 14, 1929, *H. St. John 10124* (H), with flowers (♀ only; in one of the flowers half of a sepal was petaloid); Hahaione Valley, March 19, 1932, *A. F. Judd* without number (H, NY, wood specimen Bishop Mus. no. 2491), with fruits (fruits ovoid); Kuapa Cliffs, on steep dry slope, alt. 200 m., Aug. 23, 1924, *F. B. H. Brown and A. F. Judd 1307* (H), with flowers and fruits (tree, about 7 m., diam. 20 cm., flowers greenish white [not reddish], fruits dark purple, bark gray, rough, native name: *keahi*; buds almost globular, 0.4 by 0.35 cm., opened flower 0.7-0.8 cm. in diameter, leaves rather small, up to 9 cm. long, fruits obovoid); Mokuleia, slopes of Kaala, April 26-May 16, 1912, *C. N. Forbes* without number (H, US), with fruits (fruits obovoid); right fork Wailupe Valley, Jan. 12, 1920, *D. Wesley Garber and C. N. Forbes 148* (H, L), with fruits (fruits almost globular, up to 1.1 cm. long); Wailupe Valley, April 11, 1917, *C. N. Forbes 2471 O.* (H), with fruits (leaves large, fruits globular, 1 cm.); Kaala, Makaleha, Aug. 30, 1922, *G. McEldowney and C. Skottsberg 369* (H, Göteborg), with flowers (leaves large, ♀ flowers only, some ovary cells bi-ovulate, others sterile); middle Palawai Ridge, on grassy rocky slope, decadent dry forest, May 12, 1936, *O. Degener and M. Takamoto 10666* (H), with fruits (fruits beaked, 1.3 cm. long, leaves oblong, petioles 2-2.5 cm. long); ridge with Hadden Trail, Kuliouou Valley, single tree on lantana-

covered slope, June 23, 1935, *O. Degener* and *D. Toppina 10098* (Herb. Deg.), with fruits (fruits globular to ovoid, 1.2 cm. long); talus slope southwest of Waimanalo landing, single tree, remnant of decadent dry forest, April 10, 1936, *Degener, Takamoto,* and *Martinez 11277* (Herb. Deg.), with young fruits.

Hawaiian islands, Molokai, Mauna Loa, June 1912, *C. N. Forbes 1 Mo.* (H), with fruits (fruits obovoid).

2. **Nesoluma St.-Johnianum** H. J. Lam and B. J. D. Meeuse, nov. spec. (pl. 4, figs. 80-102).

Arbor parva; folia glabra dispersa, oblonga vel elliptica vel elongato-ovata, basi acuta, apice obtusa vel paulo emarginata; nervi secundarii (8-)10-14 angulo 60°-70° de costa adscendentes, reticulatione perminuta distincta, areolis circularibus; inflorescentiae in foliorum axillis fasciculatae, ⚥ 5-12, ♀ 1-6-florae; pedicelli cum alabastris ⚥ ovoideis, ♀ oblongo-acutis glabri; corolla glabra, petala in floribus ♀ vix exserta, (5-)7-9 ovata imbricata, saepe nonnulla minora petaloidea vel staminodioidea, in floribus ♀ valde reducta, 8-0, ligulata (petaloidea) vel (sub)tridentata (staminodioidea), libera vel basi paulo connata; stamina in floribus ♀ nulla, in floribus ⚥ 8-11 glabra, interdum nonnulla minora, sterilia, staminoidea vel petaloidea; filamenta apice reflexa antheris oblongo-ovatis apice minute bifidis aequilonga vel paulo longiora; pistillum valde laticiferum, basi glabrum, ovarium 5-4(-3)-loculatum, hispido-pilosum, in stylum glabrum haud exsertum truncatum contractum; ovula fere tota anatropa; fructus monosperma obovoidei, apice plus minusve abrupte acuminati; semina characteribus generis.

A tree, up to 10 m. high and 30 cm. in diameter, the bark greenish brown, the sapwood white. Youngest parts reddish brown tomentose. Branchlets about 0.3-0.5 cm. thick, round and smooth, the older ones somewhat rugose. Leaves entirely glabrous, greenish when dry (always?), elliptic or oblong or slightly oblong-ovate, with obtuse or rounded or somewhat emarginate apex and acute base, (2.2-)4.5-15.8 cm. long, (1.6-)2.6-5.7 cm. wide, petioles rather slender, 0.9-2.5 cm. long, secondary nerves (8-)10-14 diverging at an angle of about 60-70 degrees, reticulation very minute and distinct, areoles circular. Inflorescences crowded in ⚥ flowers and 5-12-flowered, not crowded and 1-6-flowered in ♀ flowers. Pedicels glabrous or nearly so, in flower 0.4-0.7, in fruit 0.8-0.9 cm. long. Buds of hermaphroditic flowers ovoid and 0.4-0.5 cm. long, of female flowers oblong and acute, and 0.25-0.3 cm. long, 0.15 cm. in diameter. Sepals usually 4, more rarely 5, glabrous except at the tips. In ⚥ flowers corolla glabrous, hardly exserted. Petals ovate and much imbricate, (5-)7-9, often some of them smaller and then either petaloid or staminodioid. In ♀ flowers corolla much reduced, petals 8-0, if any, either ligulate (petaloid) or more or less tridentate (staminodioid), free at base or slightly connate. Stamens in ♀ flowers none, in ⚥ flowers 8-11, glabrous, the subulate filaments outwardly reflexed, as long as or somewhat longer than the oblong-ovate anthers, some of the stamens sometimes smaller and then sometimes sterile and either staminoid or petaloid. Pistil with glabrous base (with sometimes an indication of an adnate disc) and much milky juice, 0.3-0.5 cm. long, ovary hispidly pilose, usually 4-, sometimes 5- or 3-celled, style glabrous, truncate, not exserted; ovules almost fully anatropous. Fruit 1-seeded, ovoid with more

or less abruptly narrowed, acute beak, green when young, black when ripe, 1.5-1.9 cm. long, 0.7-1.0 cm. in diameter, the beak 0.3-0.4 cm. long. Seed showing generic characters, the scar (in accordance with the shape of the fruit) basilateral.

Henderson Island: north end, jungle on elevated, dissected coral, alt. 33 m., June 18, 1934, *H. St. John and F. R. Fosberg 15137*, type (H, L), with flowers and fruits (tree 8 m. high, 15 cm. in diameter; flowers whitish; some branches fasciated); same locality, June 17, 1934, *St. John and Fosberg 15105* (H, L), with flowers and fruits (tree 10 m. high, 30 cm. in diameter; flowers, ♀ only, and fruits green; bark greenish brown, sapwood white); same locality, June 18, 1934, *St. John and Fosberg 15146* (H, L), with flowers and fruits (tree 5 m. high, diameter 15 cm., flowers green, fruit black, tasting somewhat like olives, with milky juice).

Nesoluma St.-Johnianum is characterized by its large, oblong, glabrous leaves which are, as far as known, greenish yellow when dry. The areoles of the reticulation of the leaves are circular.

3. **Nesoluma Nadeaudi** (Drake) Pierre (nomen in schedula, Paris Herb.)[8] (pl. 5, figs. 103-114)[9].

Palaquium? Nadeaudi Drake: in Nadeaud, Morot's Jour. de Bot. **11**: 110, 1897.

A tree about 10 m. high, bark red inside, wood reddish and very hard (e descr.). Branchlets erect, round, tuberculate by the old inflorescences, about 0.5-0.7 cm. thick, glabrous except the very tips. Leaves glabrous, dark brown when dry (always?), elliptic or rather ovate, bluntly acute at apex, the margins entire, acute and slightly decurrent at base, 6.5-13 by (3-)3.7-5.7 cm., petioles 1.8-3(-4) cm. long, the blade rigid, midrib prominent below, secondary nerves 12-14(-16) not prominent, very slender, straight, ascending at an angle of 50 degrees in the apex and 70 degrees in the base of the leaf; reticulation very minutely and regularly areolate below, areoles circular, inconspicuous above. Inflorescences axillary, fasciculate, 2-4-flowered. Pedicels glabrous, 0.8 cm. in flower, 1.2 cm. in fruit. Flowers (not seen by me, description mostly after Pierre's annotations which in some respects disagree with Drake's description and also with Delpy's pencil drawing) in bud ± 0.4 cm. long, when open 1.2 cm. in diameter and greenish white. Calyx with 5 sepals, 2 larger outside, 3 smaller within, ovate and acute, minutely pubescent outside. Corolla with a very short tube and (5-)6 ovate petals, apparently with some additional smaller and 3-lobed ones which conform to the petaloid stamens; therefore petals and

[8] The label mentions in Pierre's handwriting: "Bull. Soc. Linn., Par. 1899", but Professor Humbert informed me that no mention of this name was found in that journal and volume (which was not available to me). Therefore it is apparently an unpublished new combination.

[9] Description of vegetative parts after the type specimen; also after the description by Drake (which is in many points wrong) and the pencil drawing by Delpy; description of flower mostly after Pierre's annotations and sketches accompanying one of the specimens.

stamens variable in number. Stamens inserted in the base of the corolla tube (7-)9-10(-12), some of them petaloid. Ovary pubescent, apparently without a glabrous basal part, 4(-5?)-celled, contracted into a glabrous conical style, the ovules ascendant with inferior micropyle. Fruit acuminate, 2.5 cm. long and 1.7 cm. in diameter, the pericarp with an abundant and very viscid latex, surrounding a single seed, attached at the very base, 1.5 cm. long and 1 cm. broad, testa hard and thick, dark brown, shining except the large, almost circular and basal scar, faintly trigonous in cross section, the embryo tangential and oblique, with abundant albumen surrounding the thin cotyledons.

Society Islands: Tahiti, "In convallibus Pinai, ad altitudinem 800 m., in (24) aprilo floret et in (12) junio (1896) fructifert", *Nadeaud 402,* type, (P); Moorea, Mount Raai'ri, near Temae, *Nadeaud* without number, Aug. 1897 (P, L).

There is one sheet of the type specimen with a branchlet and a few flower buds, bearing the number Nadeaud 402, and one sheet from Pierre's herbarium with some detached leaves, two dissected flowers and a part of a fruit. This last sheet bears a label with the name *Mimusops dissecta* (non R. Br.) Nadeaud (which is probably a *nomen nudum*) in addition to the name *Palaquium (?) Nadeaudi* Drake. There are several small sheets with annotations by Pierre together with a pencil drawing by Delpy, which, however, is wrong in some details (flower diagram, corolla, and biseriate androeceum, too regularly 5-merous throughout, which does not agree with Drake's description as compared to Pierre's annotations). The specimen from Moorea is represented by four sheets and conforms with the type, except that it is sterile. This being apparently all that is left of the material, it is too scanty to allow detailed checking. I therefore had to depend on Drake's and especially on Pierre's authority.

As has been noted by Pierre in his annotations to the specimen, the "staminodes" (= the smaller petals) may turn fertile, so the number of stamens is variable as well as that of the petals. Moreover the "small petals" or "petaloid stamens", figured in Pierre's rough sketches (copied in figs. 104-108), are found in other species of the genus. Other items of Pierre's drawings agree perfectly with those of the other species of *Nesoluma.* I therefore fully agree with Pierre as to the inclusion of the species in the genus *Nesoluma,* although further examination of more material remains highly desirable.

Nesoluma Nadeaudi is particularly characterized by its ovate, bluntly acute leaves which, as far as known, are dark brown when dry, its relatively large fruits and seeds, and the peculiar, almost basal scar of the seed.

LIST OF COLLECTORS

Brigham, W. T., see under Mann, H.

Brown, F. B. H., and A. F. Judd
1307: N. polynesicum var. β, forma b

Degener, O.
10098 (with Park and Toppina): N. polynesicum, var. β, forma b
10108 (with Park and Takamoto): N. polynesicum var. β, forma a, subf. 1
10642: N. polynesicum var. δ, forma d
10666 (with Takamoto): N. polynesicum, var. β, forma b
11277 (with Takamoto and Martinez): N. polynesicum, var. β, forma b

Forbes, C. N.
1 Mo.: N. polynesicum var. β, forma b
112 Mo.: N. polynesicum var. α, forma a
153 L.: N. polynesicum var. α, forma a
503 L.: N. polynesicum var. α, forma b, subf. 1
2074 M.: N. polynesicum var. α, forma b, subf. 2
2277 M.: N. polynesicum var. α, forma c
2471 O.: N. polynesicum var. β, forma b
no nr. (April-May 1912): N. polynesicum var. β, forma b
See also under Garber, D. W.

Fosberg, F. R.
11596: N. polynesicum var. β, forma a, subf. 2
See also under St. John, H.

Garber, D. W. and C. N. Forbes
148: N. polynesicum var. β, forma b

Hillebrand, W.
no nr. (several specimens in several herbaria): N. polynesicum var. α
no nr. (1 specimen, US): N. polynesicum var. α, forma d

Judd, A. F.
no nr. (March 1932): N. polynesicum var. β, forma b
See also under Brown, F. B. H.

Judd, C. S.
57: N. polynesicum var. β, forma a

Krajina, V.
126: N. polynesicum var. α, forma a

McEldowney, G. and C. Skottsberg
369: N. polynesicum var. β, forma b

Mann, H. and W. T. Brigham
363: N. polynesicum var. α, forma a

Munro, G. C.
31: N. polynesicum var. α, forma a
111: N, polynesicum var. α, forma b, subf. 1
955: N. polynesicum var. α, forma a

Nadeaud, J.
402: N. Nadeaudi
no nr. (1897) : N. Nadeaudi

Rémy, J.
474: N. polynesicum var. α, forma a

Rock, J. F.
2336: N. polynesicum var. β, forma a, subf. 1
7052: N. polynesicum var. α, forma d
8040: N. polynesicum var. α, forma a
8040?: N. polynesicum var. α, forma a
8671: N. polynesicum var. α, forma b, subf. 1
8671a: N. polynesicum var. α, forma a
12505: N. polynesicum var. β, forma a, subf. 1
14068: N. polynesicum var. α, forma d
17125: N. polynesicum var. β, forma a, subf. 1
no nr. (April 1928) : N. polynesicum var. α, forma d
no nr. (March 1910) : N. polynesicum var. α, forma d
no nr. (April 1928): N. polynesicum var. α, forma d

St. John, H.
10124: N. polynesicum var. β, forma b

St. John, H. and F. R. Fosberg
15105: N. St.-Johnianum
15137: N. St.-Johnianum
15146: N. St.-Johnianum
15935: N. polynesicum var. β, forma a, subf. 1
15936: N. polynesicum var. β, forma a, subf. 1

Skottsberg, C.,
See under McEldowney, G.

Stokes, A. M.
391: N. polynesicum var. β, forma a, subf. 1
406: N. polynesicum var. β, forma a, subf. 1

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LEGENDS FOR PLATES

PLATE 1 (figs. 1-9).—*Nesoluma polynesicum*: 1, var. α, forma a (from *Munro 955*); 2, var. α, forma b, subf. 1 (from *Forbes 503 L.*); 3, var. α, forma b, subf. 2 (from *Forbes 2074* M.); 4, var. α, forma c (from *Forbes 2277 M.*); 5, var. α, forma d (from *Rock 7052*); 6, var. β, forma a, subf. 1 (from *Rock 12505*); 7, var. β, forma a, subf. 2 (from *Fosberg 11596*); 8, var. β, forma b (from *McEldowney* and *Skottsberg 369*); 9, var. β, forma b (from *St. John 10124*).

PLATE 2 (figs. 10-41).—*Nesoluma polynesicum*, var. α: 10, branchlet with inflorescences; 11, flower bud; 12-16, diagrams of various calyx types; 17, corolla in bud; 18-20, diagrams of flowers; 21, longitudinal section of flower; 22, part of corolla inside, with two stamens and a "staminode" obliquely attached to one of the petals (cf. diagram below); 23, petal inside with stamen and adnate "staminode"; 24, stamen with additional filament (?), adnate to the pistillum; 25, the stamen of fig. 24 detached; 26, longitudinal section of ovary; 27, fruit; 28, seed, ventral side; 29, the same, lateral view; 30-32, various types of seeds; 33, various corollary structures, a. small outer petal, b. normal petal, c. the two types of inner petals (usually ovate though some have narrowed tip), d. two types of petaloid "staminodes" (petaloid, staminoid), e. two types of staminoid "staminodes", f. two types of scaly petals in ♀ flowers, the ligulate petaloid type (left) and the staminodial one (right, distinguished by its irregular shape, recalling tridentate staminodes); 34, diagram of flower (without calyx) with four large and four small petals and seven stamens, two of which are connate; 35, diagram of flower (without calyx) with fundamentally 5-merous corolla, two of the petals being deeply 2-lobed (see also fig. 86); in addition, there are one deltoid "staminode" and 11 stamens which are smaller (younger) in the part of the corolla in which the petals are not subject to collateral duplication; the three ripe anthers are indicated by an asterisk; 36, inner side and 37, outer side of the corolla of fig. 35; crosses indicate corresponding regions; 38, diagram of a flower with two connate petals, two "staminodes", seven stamens and six carpels; 39-41, various parts of the corolla of fig. 38 as indicated by the arrows, figs. 39 and 40 inside, fig. 41 outside; in fig. 40 the anther of the middlemost stamen has been removed. Figure 10 drawn from type specimen; 11-29 from second specimen in Berlin herbarium; 30 and 32 drawn from *Rock 8040 ?*, 31 from *Munro 955*, 34-37 from *Forbes 503 L.*, 38-41 from *Munro 111*.

PLATE 3 (figs. 42-79).—*Nesoluma polynesicum*, var. β: 42 and 43, two different calyx types; 44 and 45, diagrams of calyces, serial duplication in 44; 46, petals outside; 47, petal inside with one stamen and one "staminode" (cf. "staminode" detached and diagram above); 48, petal with one stamen and obliquely adnate "staminode"; 49, two petals with stamens opposite; 50, petal with filaments and basal hair tuft, the anther has been removed; 51, the same in longitudinal section; 52, petaloid "staminode" with hair tuft like a petal but without bearing a stamen; 53, a similar structure but bearing a stamen; 54-57, various types of staminoid or petaloid "staminodes"; 58, pistillum with longitudinal section and ovule; 59-68, ♀ flowers; 59, type of ♀ flower with exserted style; 60, diagram of same; 61, pistillum of same with longitudinal section, the corolla is scaly and of the petaloid type; 62, pistillum with free petals, one of which is larger; 63, various types of reduced petals in ♀ flowers; 64,

another type of ♀ flower; 65, pistillum of same with scaly corolla of the staminodioid type; 66, corolla of fig. 65; 67, another ♀ flower; 68, pistillum of same, corolla scaly and of petaloid type; 69, flower with petals covering part of an inner sepal, the upper portion somewhat enlarged at left; 70, diagram of this flower with petals of various sizes, two "staminodes", one of which is laterally adnate to a petal, duplication in calyx and corolla, and a bi-merous gynaeceum; 71, longitudinal sections through pistillum of the same flower with indication of an adnate disc; 72-78, ♀ flowers; 72, ♀ flower; 73, ovary and scaly corolla of same; 74, corolla of figs. 72 and 73, staminodioid type; 75 and 76 cross sections of ovaries with sterile cells, in 75 one of the cells biovulate; 77, broadened pistillum with cross section, apparently originating from two connate pistillums; 78, cross section through ovary of same (bilateral symmetry) with two biovulate cells; 79, fruit. (Figures 42-57 drawn from *St. John* and *Fosberg 15936*; 58-63 from *Fosberg 11596*; 64-68 from *St. John 10124*, 69-71 from *Brown* and *Judd 1307*; 72-78 from *McEldowney* and *Skottsberg 369*; 79 from *St. John* and *Fosberg 15935*.)

PLATE 4 (figs. 80-102).—*Nesoluma St.-Johnianum*: 80, branchlet with inflorescences (⚥ flowers); 81, portion of lower side of leaf magnified to show the areolate reticulation; 82, flower bud; 83, open flower; 84, diagram of calyx; 85-87, diagrams of three different flowers, in 86 the corolla is fundamentally 5-merous (cf. fig. 35); 88, part of corolla inside, with stamens; 89, two stamens with connate filaments from the flower of fig. 87; 90, two sterile stamens (or staminoid "staminodes"); 91, petal with two sterile stamens; 92, pistillum with longitudinal section; 93, ovula; 94, female flower, the style not exserted; 95 and 96, diagrams of ♀ flowers; 97, pistillum of ♀ flower with some free petals (petaloid type) and longitudinal section with indication of an adnate disc; 98, fruit; 99, seed, lateral view; 100, the same, ventral side; 101, the same, cross section; 102, various types of reduced petals in ♀ flowers. [Figures 80-93 drawn from *St. John* and *Fosberg 15137*; 94, 97-101 and 102 (right-hand figure) from *St. John* and *Fosberg 15105*; 95, 96 and 102 (two left-hand figures) from *St. John* and *Fosberg 15146*.]

PLATE 5 (figs. 103-114).—*Nesoluma Nadeaudi*: 103, branchlet with leaf reticulation magnified; 104, one stamen and some "staminodes"; 105, ovary with longitudinal section; 106, cross section of same; 107, one petal with two fertile stamens and one sterile one; 108, diagram of flower; 109, fruit; 110, longitudinal section of same; 111, seed, lateral view; 112, the same, ventral side; 113, apical view; 114, embryo without albumen. (Figure 103 drawn from type specimen, 104-108 from Pierre's ms. drawings; 109-114 from Delpy's ms. drawings.)

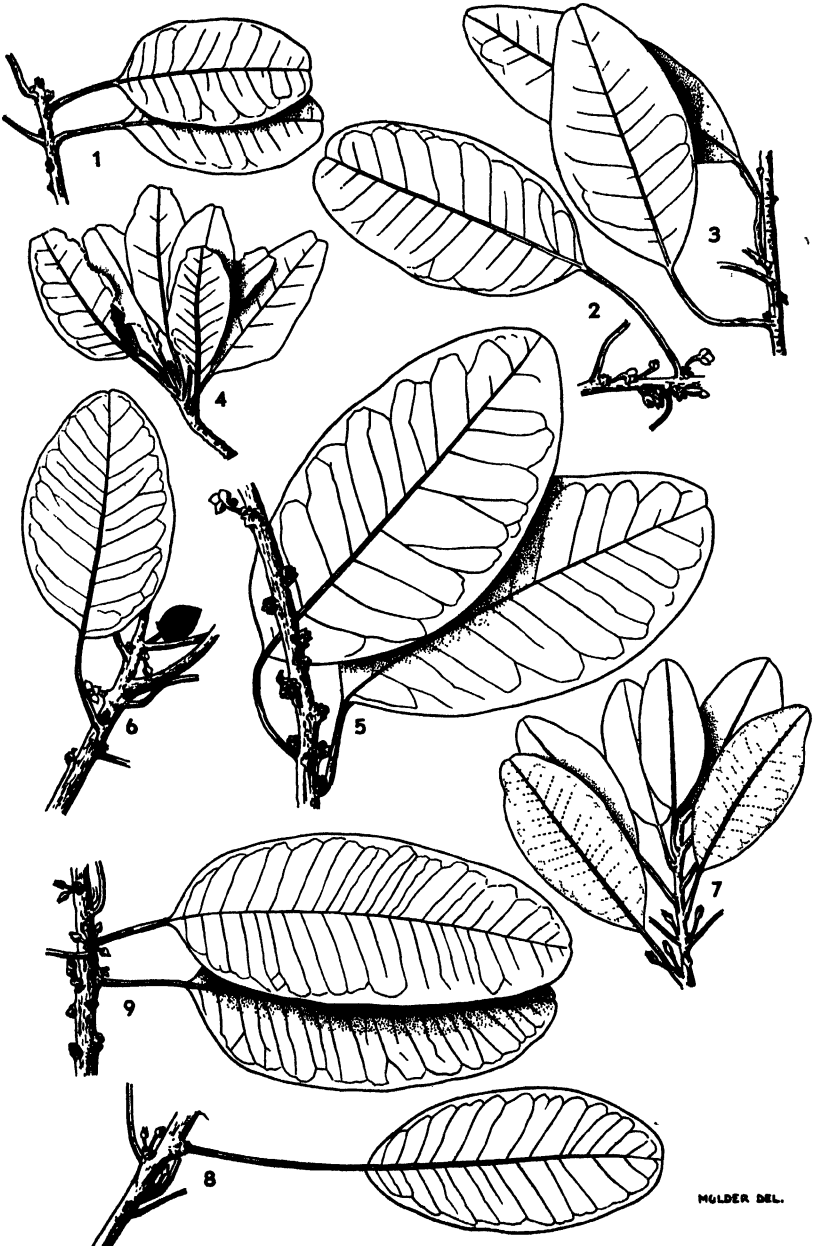

PLATE 1.—*NESOLUMA POLYNESICUM*

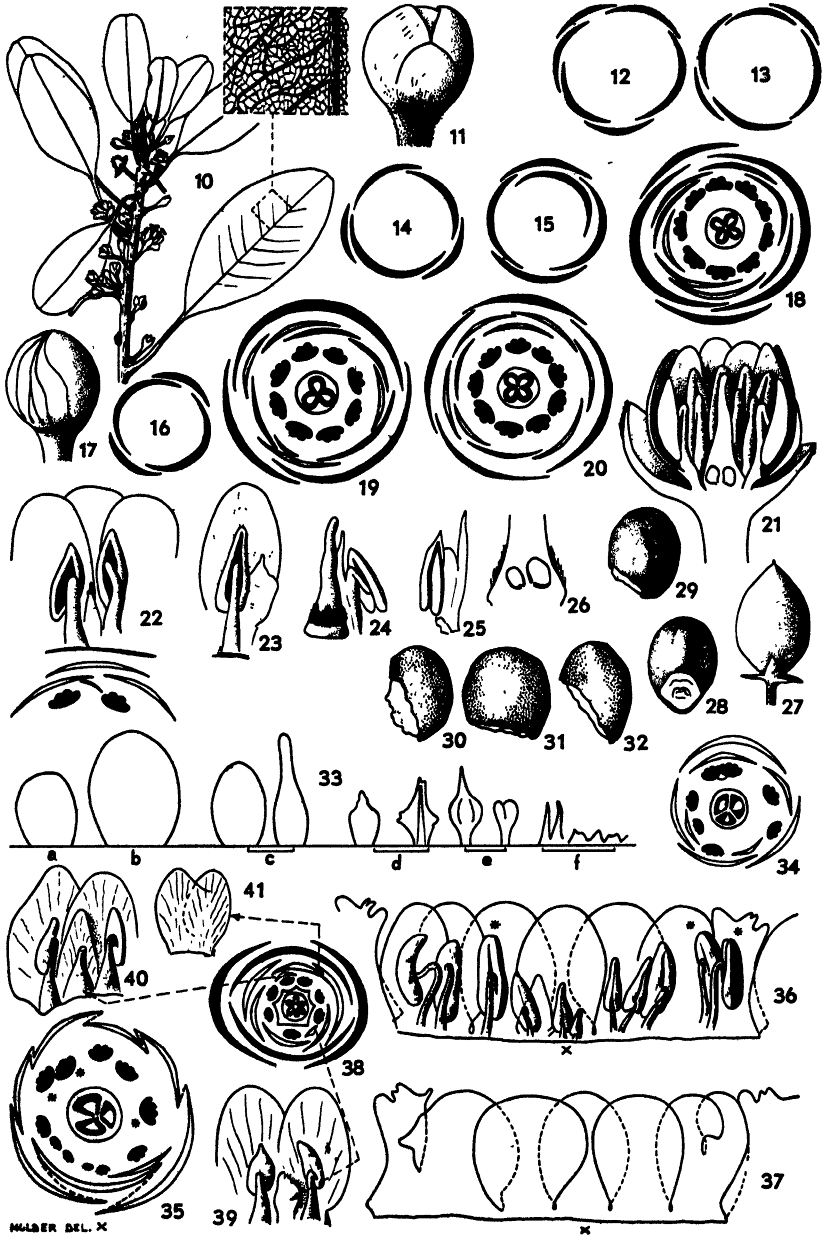

PLATE 2.—*NESOLUMA POLYNESICUM*, VAR. *a*

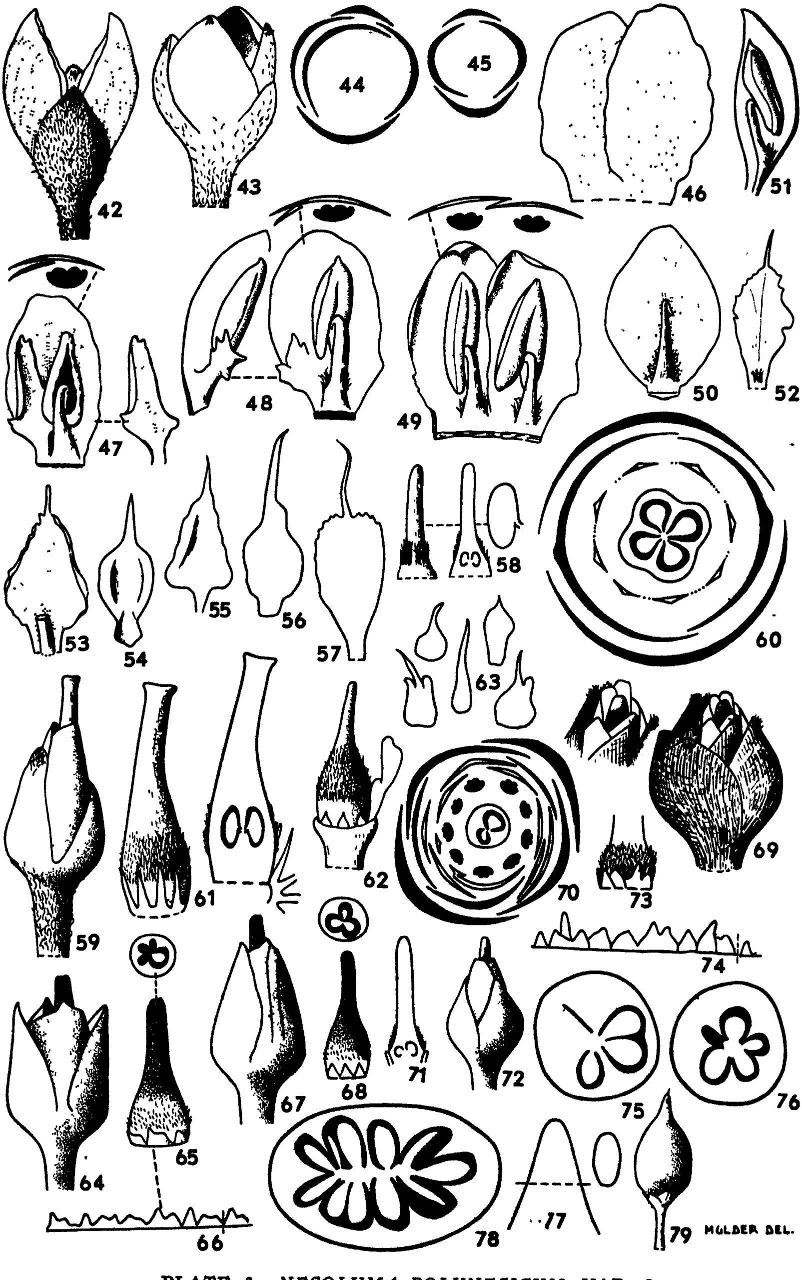

PLATE 3.—*NESOLUMA POLYNESICUM*, VAR. β

PLATE 4.—*NESOLUMA ST.-JOHNIANUM*

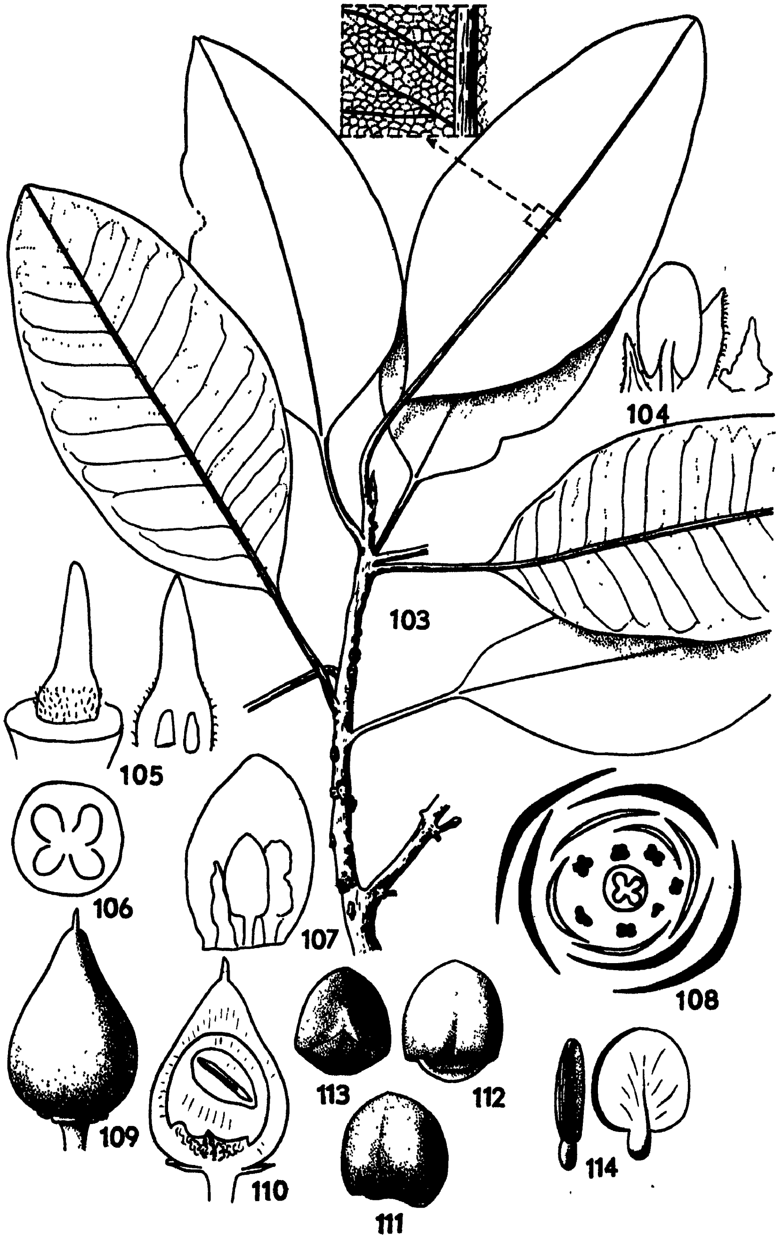

PLATE 5.—*NESOLUMA NADEAUDI*

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV October 28, 1938 Number 10

Terrestrial Isopods of Southeastern Polynesia[1]

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INTRODUCTION

This paper is the result of study of the terrestrial Isopoda collected by the Mangarevan Expedition in 1934. The islands included in the collection, with the exception of Tahiti, have never before yielded isopod specimens for investigation. In spite of assiduous collecting (133 tubes) the actual number of records is small, but, as might be expected, the proportion of new forms is very high. Of the 24 records, eleven are genera, species, or varieties new to science, and all but one are new for the localities. The type specimens of all new species are stored in Bishop Museum. The following list includes all the forms found:

1. Ligia vitiensis Dana
2. L. philoscoides, new species
3. L. rugosa, new species
4. L. pallida, new species
5. Trichoniscus thomsoni Chilton
6. Philoscia (Setaphora) truncata Dollfus
7. P. fasciata Jackson
8. P. (Paraphiloscia) gracilis var. australis, new variety
9. P. persona, new species
10. P. squamosa, new species
11. P. squamosa var. setosa, new variety
12. Alloniscus oahuensis Budde-Lund
13. Cerberoides (Philoscodillo) pilosus, new genus, subgenus and species
14. C. (Oniscomorphus) bicornis, new genus, subgenus and species
15. C. (Congloboniscus) brevicauda, new genus, subgenus and species
16. Porcellio (Mesoporcellio) laevis Latreille
17. P. scaber Latreille
18. P. (Heminagara) tahitiensis Jackson

[1] Mangarevan Expedition Publication 26.

19. P. (Porcellionides) pruinosus Brandt
20. Spherillo (Spherillo) testudinalis Budde-Lund
21. S. (Spherillo) montivagus Budde-Lund
22. S. (Xestodillo) marquesarum Jackson
23. S. (Xestodillo) marquesarum var. australis, new variety
24. Cubaris murinus Brandt

In the following pages, the names of the Expedition's collectors will be indicated by initial letters thus: Donald Anderson (DA), W. G. Anderson (WA), C. M. Cooke, Jr. (C), F. R. Fosberg (F), Harold St. John (J), Yoshio Kondo (K), S. C. Wight (W), and E. C. Zimmerman (Z).

I wish to express my indebtedness to Dr. Vera Fretter for the assistance she has given in a preliminary investigation of the material and for several admirable drawings, and to Miss Clara Vincent for preparing the manuscript for publication.

DISTRIBUTION

The most interesting feature of the spread of the recorded species is the distribution of the new forms; no fewer than ten come from the Austral Islands. New forms are marked with an asterisk.

Mangareva Islands
- Ligia vitiensis
- *L. rugosa
- Philoscia truncata
- P. fasciata
- Alloniscus oahuensis
- Porcellio laevis
- P. (Heminagara) tahitiensis
- Spherillo montivagus
- S. testudinalis
- S. marquesarum
- Cubaris murinus

Henderson Island
- Philoscia truncata
- P. fasciata
- Spherillo montivagus
- S. marquesarum

Pitcairn Island
- Philoscia fasciata
- Spherillo montivagus
- S. marquesarum

Austral Islands
- Maria
  - Porcellio (Heminagara) tahitiensis
- Rimatara
  - Spherillo testudinalis
  - S. marquesarum

Rurutu
  Philoscia fasciata
  *P. gracilis var. australis
  Spherillo marquesarum
  *S. marquesarum var. australis
Tubuai
  Philoscia truncata
  P. fasciata
  *P. gracilis var. australis
  Alloniscus oahuensis
  Porcellio (Heminagara) tahitiensis
  *Spherillo marquesarum var. australis
  S. testudinalis
  S. montivagus
Raivavae
  Philoscia fasciata
  Alloniscus oahuensis
  Spherillo montivagus
  S. testudinalis
  S. marquesarum
  *S. marquesarum var. australis
  Cubaris murinus
Marotiri
  *Ligia rugosa
  *Philoscia persona
  *P. squamosa
  *P. squamosa var. setosa
Rapa
  *Ligia philoscoides
  Trichoniscus (Megatrichoniscus) thomsoni
  Philoscia fasciata
  *Cerberoides (Philoscodillo) pilosus
  *C. (Oniscomorphus) bicornis
  *C. (Congloboniscus) brevicauda
  Porcellio scaber
  Spherillo montivagus
  S. marquesarum
  Cubaris murinus
Society Islands
  Tahiti
  Philoscia truncata
  P. fasciata
  Alloniscus oahuensis
  Spherillo testudinalis
  S. marquesarum
  Cubaris murinus
Moorea
  Philoscia truncata
  P. fasciata
  Spherillo testudinalis
  S. marquesarum
  Cubaris murinus

Huahine
    Philoscia truncata
Raiatea
    Philoscia truncata
    Porcellio (Heminagara) tahitiensis
    Spherillo testudinalis
    Cubaris murinus
Tahaa
    Spherillo testudinalis
Meetia
    Spherillo testudinalis
Fanning Island
    Alloniscus oahuensis
    Porcellionides pruinosus
    Cubaris murinus
Christmas Island
    *Ligia pallida
    Porcellio (Heminagara) tahitiensis(?)

With this collection a cursory survey of most of the important groups of islands in eastern Polynesia has been made, but it is probable that much relating to the distribution of terrestrial isopods remains to be found. In particular, data is lacking for the Cook Islands and Tonga in the Polynesian area and for Fiji. Exploration of Micronesia has scarcely begun.

The present collection adds much to our information, and it is interesting to note that, although some widely distributed species seem to recur frequently, none is found in more than nine of the twenty islands from which collections were made. On the other hand, *Spherillo marquesarum,* described for the first time from the Marquesas (5)[2], turned up in ten of these islands. Species which occur in any Pacific collection are *Spherillo testudinalis* (9 records), *S. montivagus* (6 records), *Cubaris murinus* (7 records), *Philoscia* (*Setaphora*) *truncata* (7 records), and *Alloniscus oahuensis* (5 records), but the ubiquitous *Porcellio laevis* (1 record) and *Porcellionides pruinosus* (1 record) have scarcely penetrated here.

Two species described first from the Marquesas (5) and Society Islands (4) respectively have a wider distribution, *Philoscia fasciata* occurring nine times and *Heminagara tahitiensis* five. The only remaining new species from the Marquesas, the grotesque spiny *Echi-*

[2] Numbers in parentheses refer to Literature Cited, p. 192.

nodillo montanus and *Tridentodillo squamosus,* were not found in this collection.

There would seem no logical inference to be drawn from the fact that all the new species were found in the Austral Islands, nor any reason why most of this creative energy should be centered on Rapa and Marotiri Islands with four new species apiece, unless it be that the Austral Islands are less frequently visited than other Polynesian islands. The isopods from Rapa are particularly notable for individuality. It is peculiar that in this collection the common European *Porcellio scaber* is recorded only from Rapa and that it was collected there no less than thirteen times. It is otherwise recorded in the Pacific from the Hawaiian islands, New Zealand, Juan Fernandez, and the Galapagos Islands. It is to be hoped that the author of this unconscious introduction has not, in satisfying his desire for European horticulture, sealed the doom of the indigenous isopod fauna of this particularly interesting island. The presence of *Porcellio scaber* serves, however, to emphasize the urgency of studying the fauna of the Pacific islands before the picture is further distorted. Another interesting record from Rapa is that of *Trichoniscus thomsoni,* the first endemic New Zealand form to be recorded elsewhere in Polynesia.

A survey of the recorded species will make it clear that southeastern Polynesia has no affinity with Hawaii or America and less than might be anticipated with Australia and New Zealand.

The only form which must be attributed to America, if the identification of the single specimen is correct, is *Rhyscotus ortonedae* Budde-Lund (or *R. laxus* Van Name) from Samoa (3); the only form in common with Hawaii is *Ligia perkinsi* Dollfus which is also recorded from Samoa (3).

Of the typical New Zealand species, *Ligia novae-zealandiae* Dana is unrecorded from this region and no species of *Tylos, Scyphax, Deto, Scyphoniscus* or *Actaecia* have been found; but, as pointed out above, most of the widely distributed species find their nearest relatives to the west and seem to have spread from a northwesterly direction.[8]

The lack of records for any species of *Trichoniscus* other than

[8] The question of the geographical distribution of the terrestrial isopods of the Pacific islands is fully discussed in my "Check list of the terrestrial and freshwater isopods of Oceania" now in course of publication.

T. thomsoni is probably due to their minute size and inconspicuousness rather than to their actual absence.

LIGIIDAE

Ligia vitiensis Dana.

Mangareva Islands: Mangareva, north of Rikitea, at sea level, May 30, 1934 (F).

It is not surprising that this species should be found in the Mangareva Islands, as it has already been recorded from New Guinea, Fiji, and the Marquesas. As I have pointed out (5, p. 149), it is undoubtedly distinct from *L. hawaiensis*.

Ligia rugosa, new species (figs. 1, *a-c*; 2, *c-d*).

Length, male 11.5 mm., female (ovigerous) 10.5 mm.; breadth, male 4.5 mm., female 5.5 mm.

Shape, elongate oval. Surface, scabrous. Color, in alcohol, dark slaty gray.

Head. Of "oceanica" type. Eyes moderately large, separated by nearly twice their breadth. Supra antennal line with pronounced V in midline. Upper border of clypeus nearly transverse.

Thorax. Hind border of first three tergites almost straight, remainder increasingly curved but postero-lateral angles never long. Coxal plates separate on 2, 3, 4, and 5 tergites on ovigerous female (indistinct on other females), not visible on male.

Abdomen. Slightly contracted; postero-lateral angles little drawn out. Telson, hind border almost arcuate with faint indication of median angle; no lateral angles and only slight undulations in place of accessory processes; about twice as broad as long.

Appendages. Antenna very long, reaching to third or fourth abdominal somite (in the ovigerous female longer than whole body), flagellum 21-22 articulations, fifth segment about one third longer than fourth. Mandibles: both with few penicilli. Maxillula: outer endite, all simple, but single feathery plume present; inner endite, penicilli very unequal, two proximal long and slender, distal very small, distant from others and mounted on separate terminal setose segment. Maxilla without penicilli. Maxillipede; endite, setose tip, only two stout spines, one on inner edge and one on face, near to inner spine a short brush; endopod expanded on inner edge. Uropod: protopod with small outer tooth; exopod very slender, shorter than endopod; endopod moderately stout and tipped with very long bristle; whole uropod at least one third whole length of body. First peraeopod of male without tooth on propos.

Mangareva Islands: Mangareva, north of Rikitea, at sea level, May 30, 1934 (F).

Austral Islands: Marotiri, southeastern islet, July 22, 1934 (Z, F).

This species differs from all others in the form of the telson, which is entirely without processes. The mouthparts are also sharply

distinct, especially the inner endite of the maxillula and the endite of the maxillipede. Few species have the markedly granulate surface of this one.

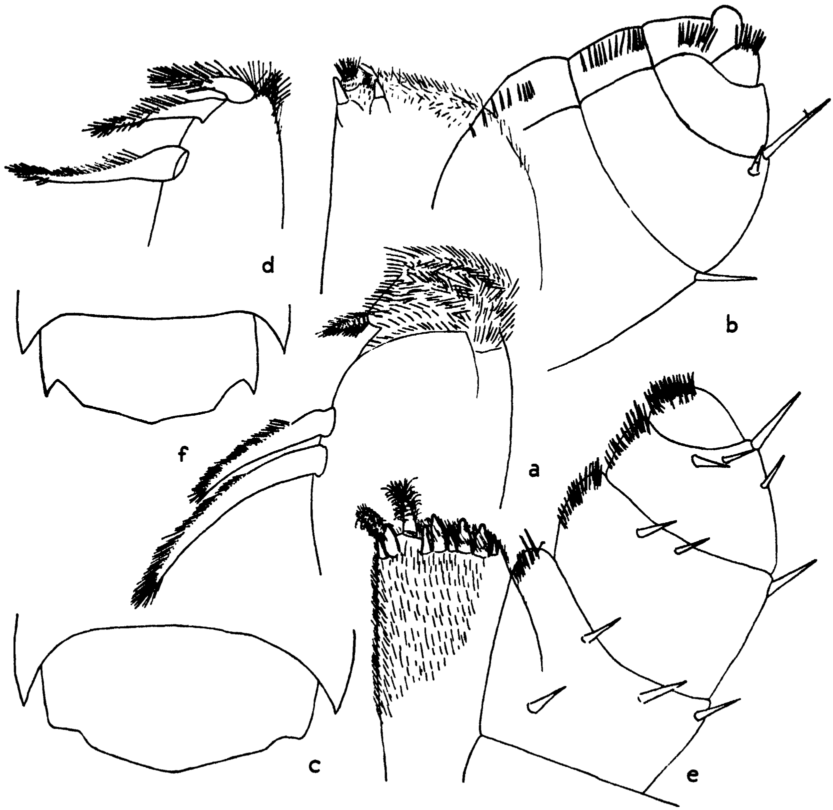

FIGURE 1.—*Ligia rugosa*, new species: *a*, maxillula, inner endite; *b*, maxillipede; *c*, telson. *Ligia pallida*, new species: *d*, maxillula, inner endite; *e*, maxillipede; *f*, telson.

Ligia philoscoides, new species (fig. 2, *a-b*).

Length, male 7.5 mm.; female 9.5 mm.; breadth, male 3.5 mm., female 4.75 mm.

Shape, elongate oval. Surface, very smooth and shining. Color, in alcohol, heavily pigmented, a mottled grayish brown.

Head. Eyes large, separated by little more than their breadth. Antennary tubercle well marked and flattened, distinct margin on which supra-antennary line runs. Frontal line dips down in front of eye and joins antennary tubercle. Supra-antennary line nearly linear in midline, not forming V. Frontal lamina a tumid roll. Clypeus nearly transverse.

Thorax. Hind border of first three tergites transverse, remainder progressively curved, postero-lateral angles little drawn out. Coxal plates very faintly separated in both sexes and almost obsolescent in male.

Abdomen. Slightly contracted, postero-lateral angles little drawn out. Telson without postero-lateral angles or accessory processes; hind border very bluntly triangulate. About one and a half times as broad as long. Indistinct transverse groove between insertions of uropods.

Appendages. Antenna very long and slender reaching to hind border of last abdominal somite in both sexes; flagellum 23 articulations; fifth segment slightly longer than third.

Mouthparts similar to *L. rugosa* but inner endite of maxillula has the following differences: the penicilli are progressively smaller from proximal to distal, the most distal is very heavily setose giving it a multi-articulate appearance and is larger than the corresponding one in *L. rugosa*. Uropod: a detached appendage very slender, base has tooth and is about two thirds the length of the rami. Peraeopoda, very slender; first of male without tooth on propos.

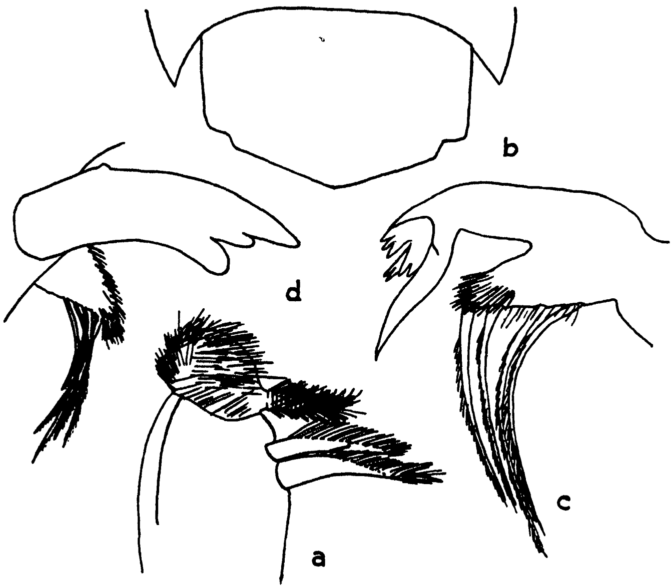

FIGURE 2.—*Ligia philoscoides*, new species: *a*, maxillula, inner endite; *b*, telson. *Ligia rugosa*: *c*, right mandible; *d*, left mandible. (Omitting incisor and molar parts.)

Rapa: above Area, alt. 378 ft., under stones, July 1, 1934 (F); Mount Perahu, east ridge, alt. 1,400-1,600 ft., July 28, 1934 (Z); Karapo Rahi Islet, alt. 100-300 ft., July 18, 1934 (Z).

This terrestrial form is closely related to the littoral *L. rugosa*, from which it differs in its surface, the minute structure of the head,

the maxillula and other slight features. Three species of terrestrial *Ligia* have been described, but this is another instance of the tendency of members of the genus to attempt to establish themselves far from the seashore. It is a much smaller species than *L. perkinsi,* which has been recorded from Samoa, and differs from it in antenna, mouthparts, and telson.

Ligia pallida, new species (fig. 1, *d-f*).

Length, male 13.5 mm., female 8.5 mm.; breadth, male 5 mm., female 3.5 mm.

Shape, elongate oval. Surface smooth, rather shining, very minutely scaly, almost devoid of undulations. Color, in alcohol, cream, with diffuse chromatophores dotted sparsely over surface.

Head. Of "oceanica" type. Eyes moderately large and separated by their width. Clypeus upper border slightly curved.

Thorax. Hind border of first three tergites straight, remainder progressively drawn out; postero-lateral angles moderately produced. Coxal plates not separated in male, very faint in female.

Abdomen. Not abruptly contracted. Telson, postero-lateral angles prominent, accessory processes blunt, posterior border very bluntly triangulate. More than twice as broad as long.

Appendages. Antenna short and stout. In male scarcely reaches hind border of sixth tergite, in female just beyond fourth. In male, flagellum has 25 and in female 20 stout short articulations.

Mandibles, both with few penicilli. Maxillula: outer endite, four inner teeth ctenate, remainder simple; inner endite, proximal penicilla very long, two distal about one third proximal and equal, distal end setose. Maxilla without penicilli and very setose. Maxillipede: endite with four bottle-shaped and four sharp, flat spines on distal edge of ventral face and two stout, brush penicilli; setose. Peraeopoda. Propos of first leg of male with tooth; carpos and meros with concave, transversely ridged surfaces on lower side. Uropod missing.

Christmas Island: around edge of drying salt pool under dry pieces of gelatinous algae, Oct. 22, 1934 (F).

The telson of this form resembles that of *L. australiensis* Dana, but the surface is smooth and not granulate and Dana's specimen was too incomplete to make further comparison possible. The short antennae, color, telson, and other characters separate this species from all others.[4]

[4] In his paper on the Isopoda of New Caledonia (6), Verhoeff subdivides the genus *Ligia* Fabricius into five genera and gives further characters for three of them in a later paper (7). The characters used are so detailed that it is doubtful whether any but the genotypes will conform to them. The subdivisions are not based on a complete survey of the group nor do they seem to me to have more than subgeneric value. None of the species described above can be placed in Verhoeff's subdivisions. By amending Verhoeff's definitions, *Ligia rugosa* and *Ligia philoscoides* might be forced into his "Ligia" and *Ligia pallida* into "Megaligia", but I prefer to leave them in *Ligia* Fabricius pending a critical analysis of the whole genus.

TRICHONISCIDAE

Subgenus MEGATRICHONISCUS, new subgenus

With general characters of *Trichoniscus,* but body is broad oval in shape and the tergites are hard, shiny, and well calcified. The lateral plates of the first tergite are large and nearly enclose the head so that the front appears broad and rounded. Antennary tubercles not strongly developed. Eyes with three widely separated ocelli. Antennal flagellum of five or more segments. Epimera relatively well developed. Abdomen abruptly contracted.

This subgenus is created to contain Chilton's species *Trichoniscus thomsoni* (1886), two specimens of which have been found on Rapa Island. *Trichoniscus magellanicus* (Dana) also should come under this subgenus and possibly, though more doubtfully, *Trichoniscus murrayi* Dollfus. These are giants among trichoniscids and have the superficial appearance of a *Porcellio* or *Philoscia,* very unlike the minute, slender, delicate-bodied forms which make up the majority of this family.

Trichoniscus (Megatrichoniscus) thomsoni (Chilton), (fig. 3).

Philygria thomsoni Chilton; New Zealand Inst., Trans., **18,** 1886.

Trichoniscus thomsoni (Chilton): Linn. Soc. Zool., Jour., **8,** 1901; Wahrberg, Arkiv. für Zool., **15,** 1922; Stephenson, Vidensh. Meddel. Dansk. Nat. Foren., **83,** 1927.

The following points may be added to Chilton's description:

Color, a uniform chocolate brown, except for light muscle markings on middle of thorax and top of head. Profrons uniform brown.

Head. Eyes: three large ocelli, two lateral ones at each end of sausage-shaped roll. Supra-antennal line very well marked, dipping very deeply between antennary sockets. Lateral process of clypeus styliform.

Thorax. Coxal plates distinct on 2 and 3, less so on 4 (female specimen).

Abdomen. Abruptly contracted, angles adpressed but visible from above. Flattened dorso-ventrally. Telson truncate. Base of uropod exceeds telson; exopod long and styliform; endopod reaches halfway up exopod and set but little proximal to it on base.

Rapa: east base of Mount Perahu, alt. 100-300 ft., July 21, 1934 (Z); east ridge of Mount Perahu, alt. 1,200-1,500 ft., July 21, 1934 (Z).

Also occurs on Auckland Islands, New Zealand, and Jarrahdale, Western Australia.

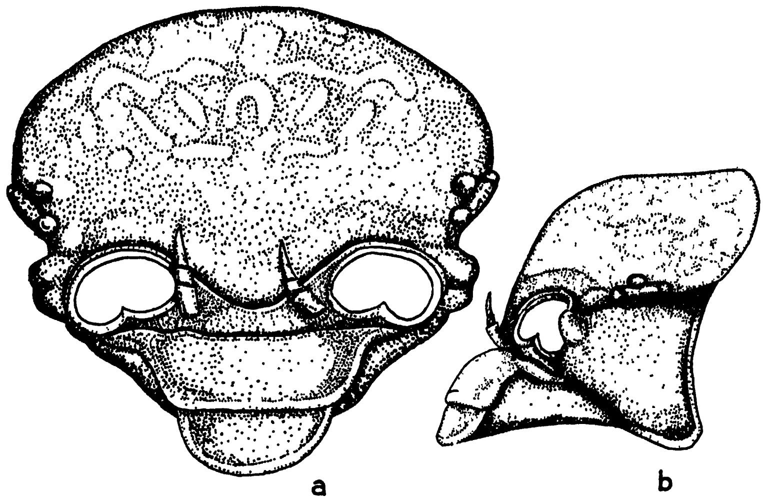

FIGURE 3.—*Trichoniscus* (*Megatrichoniscus*) *thomsoni*: *a*, head from front; *b*, head from side.

ONISCIDAE

SUBFAMILY ONISCINAE

Philoscia (Setaphora) truncata Dollfus.

Mangareva Islands: Mangareva, Rikitea, May 27, 1934 (F).

Henderson Island, alt. 5 ft., in base of *Asplenium nidus*, June 21, 1934 (F).

Austral Islands: Tubuai, Mount Taitaa, alt. 1,000 ft., Aug. 15, 1934 (Z); west of Mataura, Aug. 23, 1934 (C).

Rapa: southeast valley, Mount Ororangi, alt. 600-700 ft., July 3, 1934 (Z); top, Mount Ororangi, July 6, 1934 (F); Mount Perahu, north ridge, 2,050 ft., under dead leaves, July 28, 1934 (F).

Society Islands: Tahiti, Papeari, Nr. Vaitaare, March 24, 1934 (Z); Papenoo Valley, alt. 1,500 ft., under stones and in moss, Sept. 16, 1934 (F). Moorea, Mount Teaharoa, north slope, 1,500-2,000 ft., Sept. 25, 1934 (Z). Huahine, Mount Turi, northwest ridge, 1,700-2,100 ft., Oct. 1, 1934 (Z). Raiatea, Faaroa Bay, northwest ridge, 300-500 ft., Oct. 6, 1934 (Z).

Philoscia (Paraphiloscia) gracilis var. **australis,** new variety (fig. 5, *d*).

Paraphiloscia gracilis (B. L.) Jackson: Insects of Samoa, **8** (1): 8, 1927.

This species has been recorded from Samoa (which is the type locality), and the specimens collected from Tubuai in the Austral Islands—Mount Taitaa, alt. 1,000 ft., Aug. 19, 1934 (C), and from the southwest ridge of Mount Taitaa, Aug. 20, 1934, at 1,200 ft. (Z) —resemble the Samoan species so closely that it does not seem justifiable to create a separate species for them.

The points of difference upon which this variety is founded are as follows: the flagellum is slightly shorter than the fifth segment of the antenna, the articles of the flagellum are equal; the telson is triangulate but not so sharp as in *P. gracilis,* the angle being distinctly blunt. The color is brown, evenly mottled, with the midline sometimes with a median stripe; the fifth somite is not darker than the others. In mouthparts and all other characters these specimens agree with *P. gracilis.*

Philoscia persona, new species (fig. 4).

Length, male 6 mm., female 5.5 mm.; breadth, male 2.5 mm., female 2.25 mm.

Shape, elongate oval. Surface, moderately smooth and shiny; minutely pitted, like orange skin. Color, in alcohol, tergites 1, middle of 2 and 5 cream, remainder purple brown. Head with dark profrons contrasting sharply with yellow vertex and postfrons, giving a masklike appearance to the face. Antenna dark brown.

Head discrete. Eyes moderately large, 20 ocelli. Supra-antennal line prominent, deeply curved in middle. Profrons darkly pigmented, contrasting with yellow vertex and profrons. In general, form typical of the genus.

Thorax. Hind borders of tergites 1 to 5 gently sinuate, 6 and 7 curved; postero-lateral angles only feebly developed on 6 and 7.

Abdomen. Epimera not adpressed, but prominent on 4 and 5; not very contracted. Telson almost arcuate, scarcely emarginate at sides, median angle not developed.

Appendages. Antennae slender; flagellum with three subequal articles, as long as fifth segment; reaches to hind border of second tergite. Mandibles: right penicilli 2+0; left penicilli 1+2. Maxillula: outer endite, 4+4 (all simple); inner endite without spine, penicilli moderately long and not stout. Maxilla: outer lobe lamellate, very sparsely setose; inner lobe coarsely setose; two stout bristles between the two. Maxillipede: endite with strong vertical comb of setae on inner face, distal end minutely setose, outer corner with one sharp spine, one large spine on face. Pleopoda: first of male oval in form, without angles or projections. Uropod: protopod small, not exceeding telson; exopod lanceolate and short; endopod, three fourths exopod, flat, set slightly proximal to exopod.

Austral Islands: southeast islet, Marotiri, July 22, 1934 (Z, F).

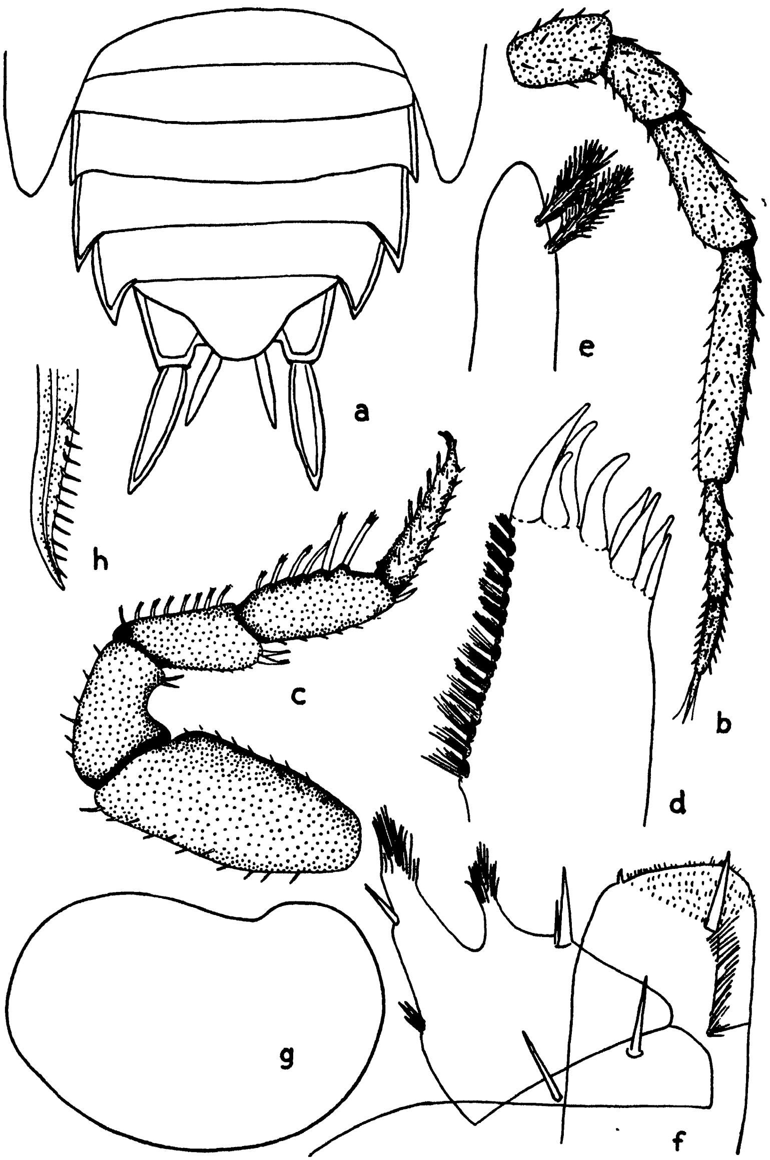

FIGURE 4.—*Philoscia persona*, new species: *a*, abdomen and telson; *b*, antenna; *c*, 1st peraeopod, ♂ ; *d*, maxillula, outer endite; *e*, maxillula, inner endite; *f*, maxillipede; *g*, 1st exopleopod, ♂ ; *h*, tip of endopod of 1st pleopod, ♂ .

Philoscia squamosa, new species (fig. 5, *a-c*).

Length, male 3.75 mm., female 5 mm.; breadth, male 1.25 mm., female 2.5 mm.

Shape, elongate oval. Surface, very rough, uniformly covered with "schuppenborsten" and scales. Color, in alcohol, even light purplish brown, muscle markings in white.

Head discrete. Eyes small, 12 ocelli. Supra-antennal line prominent, deeply curved in midline. In general form, typical of the genus.

Thorax. Hind borders of 1 to 4 tergites transverse, 5 scarcely curved, 6 and 7 curved. Postero-lateral angles absent up to 6, which is little drawn out.

Abdomen. Epimera adpressed but distinctly visible from above, abruptly contracted. Telson, hind border bluntly triangulate, almost arcuate, median angle obsolete.

Appendages. Antenna rather stout; flagellum with three articles, the two proximal of which are shorter than the third and together about equal to it. Very setose. Mandibles: right penicilli 2+0; left penicilli 1+2. Maxillula: outer endite 4+4 (all simple); inner endite without spine, two short but not stout penicilli. Maxillipede: endite with strong, vertical comb of setae on outer face; distal end sparsely setose; outer corner with small triangular spine, large spine on face. Pleopoda: first of male oval, without angles or projections. Uropod: protopod shorter than telson; exopod moderately long and slender; endopod short, about one-half exopod and set slightly proximal to it.

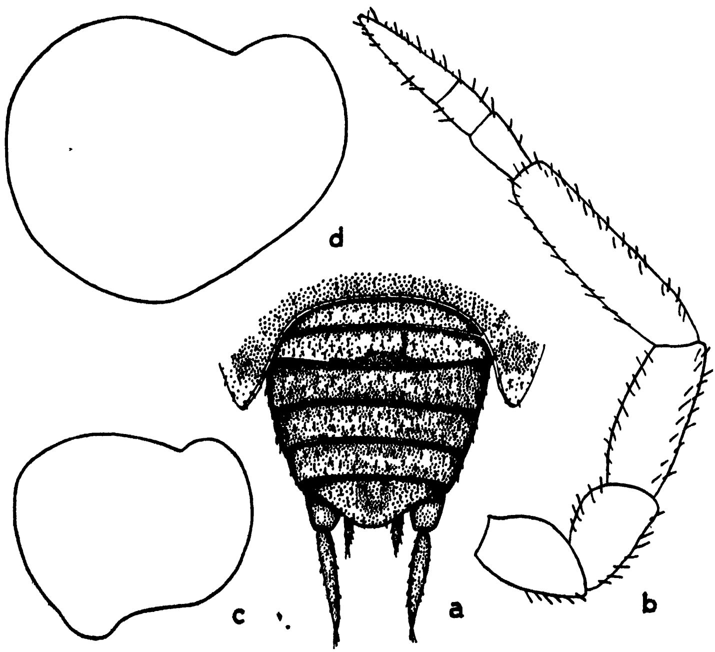

FIGURE 5.—*Philoscia squamosa,* new species: *a,* abdomen and telson; *b,* antenna; *c,* 1st exopleopod, ♂. *Philoscia* (*Paraphiloscia*) *gracilis* var. *australis,* new variety: *d,* 1st exopleopod, ♂.

Austral Islands: southeast islet, Marotiri, July 22, 1934 (Z, F).

Although collected at the same place and time as *P. persona, P. squamosa* differs markedly from it and is peculiar for the richly setose surface. Neither of these new species fits comfortably into the existing subgenera of *Philoscia,* numerous though these be. I am most unwilling to add to their number, which already vie with each other in the triviality of the characters by which they are divided.

Philoscia squamata var. **setosa,** new variety.

Strikingly hairy appearance. The antenna is short and the flagellum has three subequal articles. From the same locality as *Philoscia squamosa.*

Philoscia fasciata Jackson.

Mangareva Islands: Mangareva, under coconut log, May 27, 1934 (F); Rikitea, May 24, 1934 (C), May 31, 1934.

Pitcairn Island: south side, June 14, 1934 (F).

Henderson Island: alt. 100 ft., under dead leaves, June 20, 1934 (F); northwest side, alt. 100 ft., June 21, 1934 (Z).

Austral Islands: Tubuai, back of Arana Village, Aug. 22, 1934 (W A). Rurutu, bluffs of Avera, Aug. 28, 1934 (W); Mato Naa, Aug. 29, 1934 (W A); southwest slope of Mount Manureva, alt. 1,100 ft., Aug. 29, 1934 (Z); southeast slope of Mount Manureva, alt. 1,100 ft., Aug. 30, 1934 (Z). Raivavae, east slope of Mount Muanui, alt. 500-800 ft., Aug. 8, 1934 (Z); near Ahuoivi Point, Aug. 9, 1934 (Z); Mount Muatapu, Aug. 11, 1934 (F).

Rapa: near Ahurei, wet face of cliff, alt. 150 ft., July 1, 1934 (F); northwest slopes of Mount Tautautu, alt. 700-800 ft., July 9, 1934 (Z); Maitua, alt. 600-800 ft., July 2, 1934 (Z).

Society Islands: Tahiti, Papeari, Tiupi Bay, March 19-21, 1934 (Z); Taohiri, Mount Aorai Trail, alt. 3,500 ft., Sept. 12, 1934 (Z). Moorea, north slope of Mount Teaharoa, 1,500-2,000 ft., Sept. 25, 1934 (Z); Faatoai Valley, alt. 100-300 ft., Sept. 23, 1934 (Z).

Described from the Marquesas (5) and recorded from Tahiti. The species is evidently widely distributed in Polynesia.

Alloniscus oahuensis Budde-Lund.

Mangareva Islands: Rikitea, under coconut log, May 27, 1934 (F); Aukena, northwest side, May 28, 1934 (Z); Aha Mara, sea level, under half coconut, May 30, 1934 (C).

Austral Islands: Tubuai, Murivai, alt. 10 ft., Aug. 11, 1934 (Z). Raivavae, alt. 10 ft., Aug. 12, 1934 (Z).

Society Islands: Tahiti, Papeari, Tiupi Bay, April 4, 1934 (Z).

Fanning Island: Vai Tepu, April 25, 1934 (F).

Reasons for the identification of this species with *A. brevis* Budde-Lund are given in my Marquesas paper (5). It seems to be widely distributed in Polynesia.

Genus CERBEROIDES, new genus

Epimera absent on first, second, and third abdominal somites.

Head. Lateral lobes present; frontal and supra-antennal lines present or absent; antennal flagellum triarticulate; general structure of mouthparts *Philoscia*-like; inner endite of maxillula with two short and stout penicilli. Pseudotracheae weakly developed on all pleopoda. Thoracic epimera weakly developed. Telson bluntly triangulate.

It would seem that the loss of the epimera of the third abdominal somite has only been recorded once before in the terrestrial isopods, by Chilton in *Notoniscus* (2), a genus allied to *Haplophthalmus* of the Trichoniscidae. This character is sufficiently remarkable to group together the three subgenera described below in spite of their otherwise divergent characters. Except for this character they would superficially seem to have little in common, the general facies of each being that of an "Armadillo", a "Philoscia", and an "Oniscus". The very conservative mouthparts, however, which are surprisingly enough almost identical in the three forms, bind them together and make association with any other group but the subfamily *Oniscinae* impossible.

One may conjecture that all three forms have evolved from a *Philoscia*-like ancestor; one retaining many of the characters and habits of *Philoscia* (recorded from "under stones" at 700 ft.), another moving in the direction of the Porcellionine forms ("in dead tree fern fronds" at 1,300-1,500 ft.), and a third becoming most emphatically modified as a "conglobating" form, probably with more power of resisting desiccation than the others (the collector gives no habitat for this form, simply 1,000-1,100 ft.). The stability of the mouthparts during these considerable changes in form and perhaps habitat, seem to justify the faith placed by most students of this group in their value as a basis for classification.

Subgenus PHILOSCODILLO, new subgenus

Head. Lateral lobes tumid and slightly produced; frontal line absent; supra-antennal line strong. Postero-lateral angles of thoracic tergites very weak and rounded or absent.

Cerberoides (Philoscodillo) pilosus, new species (fig. 6). (For mouthparts see fig. 8, *a-d.*)

Female only. Length 3.75 mm., breadth 1.75 mm.

Shape, oblong oval. Surface, smooth, minutely scaly and setose. Color, in alcohol, leaden purple with uniform yellow markings; mid-dorsal line yellow.

Head. Eyes small, 10 ocelli. Lateral lobes tumid rolls, only slightly produced; median lobe absent; marginal line dips sharply below eye (discrete); frontal line inconspicuous, but upper margin of profrons is marked by a distinct fold; supra-antennal line distinct, low on face restricting postfrons, curved in midline becoming indistinct over antennary sockets; antennary tubercle small and inconspicuous; lateral processes of clypeus large.

Thorax. Hind margin of tergites all slightly sinuate; postero-lateral angles absent on 1 to 4 and bluntly rounded on remainder.

Abdomen. Very short, the postero-lateral angles of the thoracic tergite 7 attaining hind border of abdominal tergite 4. Epimera absent on 1, 2, and 3, well marked on 4 and 5. Telson bluntly triangulate, apex slightly exceeding 5; twice as broad as long.

Appendages. Antennule slender, three equal segments. Antenna absent. Mandibles: right, penicilli 2+0 (?); left, penicilli 1+2. Maxillula: outer endite 4+5 (all simple); inner endite without spine, penicilli short and stout. Maxilla: outer lobe sparsely setose; inner strong coarse setae; between the lobes three spines. Maxillipede: endite minutely setose at distal end, one small tooth at outer corner, short brush at inner corner, one large bristle on face. Pleopoda: rudimentary pseudo-tracheae present. Uropod: protopod slightly shorter than telson, nearly as broad as long; exopod and endopod equal in length and short, endopod originates much above exopod, flattened laterally.

Rapa: south side of Mount Tanga, under stones, alt. 700 ft., July 23, 1934 (DA).

The conformation of the lateral plates of the tergites and the abbreviated uropods suggest that this form has considerable powers of rolling up, but, if so, it is a primitive specimen of that genre, as the head is in essentials of the "Philoscia" type, without any tendency toward the characteristic flattening and frontal shield of typical rolling forms.

Subgenus ONISCOMORPHUS, new subgenus

Head. Lateral lobes prominent, blunt, and fingerlike; median lobe slight; frontal line strong and low; supra-antennary line absent. Postero-lateral angles of thoracic tergites slightly produced.

Cerberoides (Oniscomorphus) bicornis, new species (figs. *7*; 8, *a-d*).

Female only. Length 5.75 mm., breadth 3.5 mm. Shape, oblong oval. Surface smooth, shining, minutely scaly. Color, in alcohol, yellow ground mottled with brown pigment.

Head. Eyes small, 10 ocelli. Lateral lobes prominent and somewhat bulbous; median lobe slightly produced; marginal line turns down in gentle curve below eyes; frontal line well marked, curves down low on face and on each side runs up above lateral lobes without joining them; supra-antennal line absent except at each side above antennal sockets, on each side of which it joins antennary tubercle; lateral processes of clypeus small, pointed and slender.

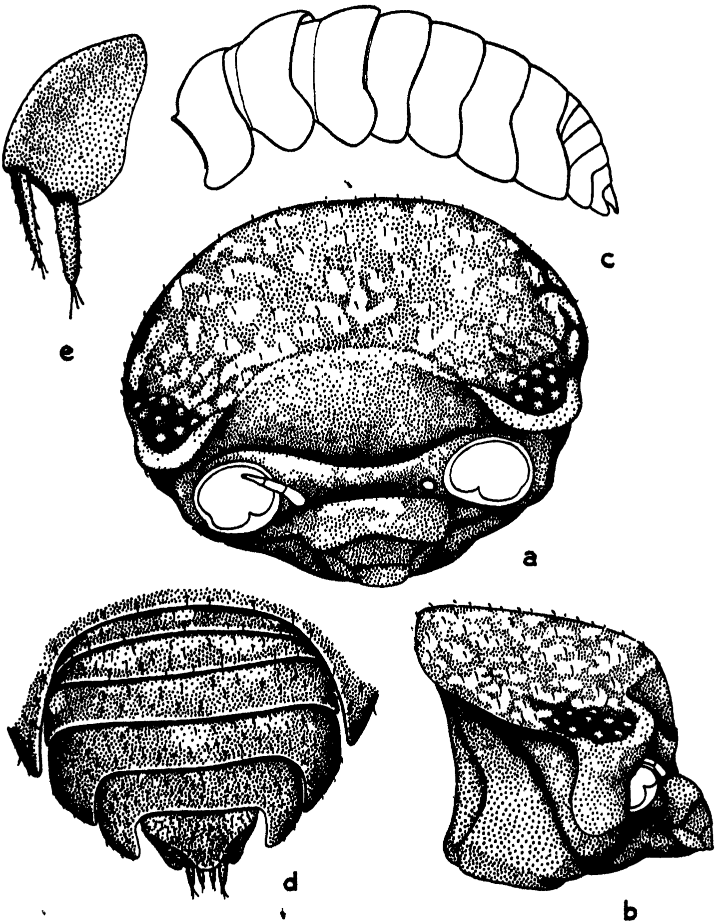

FIGURE 6.—*Cerberoides* (*Philoscodillo*) *pilosus,* new species: *a,* head from front; *b,* head from side; *c,* thorax and abdomen from side; *d,* abdomen and telson from above; *e,* uropod.

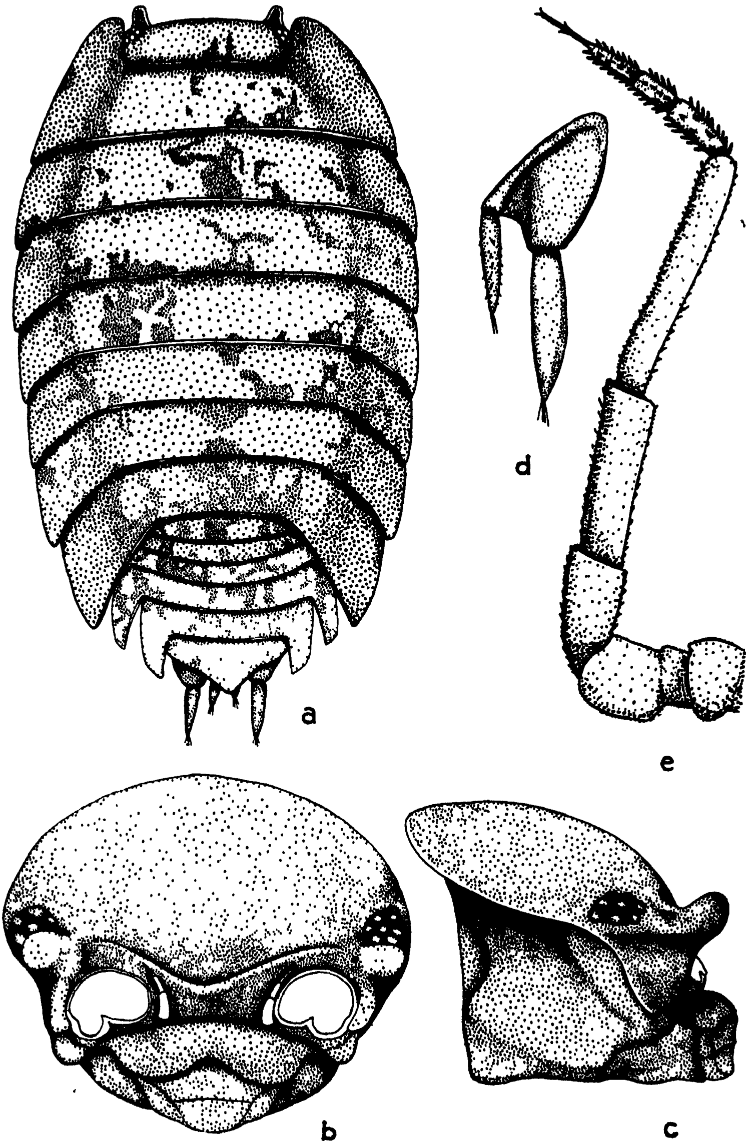

FIGURE 7.—*Cerberoides* (*Oniscomorphus*) *bicornis*, new species: *a*, whole specimen from above; *b*, head from front; *c*, head from side; *d*, uropod; *e*, antenna.

Thorax. All tergites curved, very slightly in front and increasingly behind; postero-lateral angles very slightly formed.

Abdomen. Very short, postero-lateral angles of thoracic tergite 7 surpassing the hind border, but not the epimera, of abdominal tergite 4. Epimera absent on 1, 2, and 3; very well formed on 4 and 5. Telson bluntly triangulate, lateral borders emarginate; apex exceeding 5; twice as broad as long.

Appendages. Antenna: flagellum of three subequal articles, shorter than fifth segment. Mouthparts as described for *Philoscodillo* above. Pleopoda: rudimentary pseudo-tracheae present. Uropod: protopod slightly shorter than telson, breadth two thirds length, excavated on lower face; exopod lanceolate, short; endopod originating well above exopod and two thirds its length.

Rapa: northeast ridge of Mount Perahu, in dead tree fern fronds, alt. 1,300-1,500 ft., July 15, 1934 (Z).

Except for the shortness of the abdomen and the relatively poorly developed postero-lateral angles, this form has the superficial appearance of an *Oniscus*. The head is, however, fundamentally different in detail and is susceptible of another interpretation than that given above. The lateral lobes may be looked upon as greatly hypertrophied antennary tubercles (as in *Deto*) and the lines between them as the supra-antennal line. More specimens would make a dissection of the head possible and settle the point.

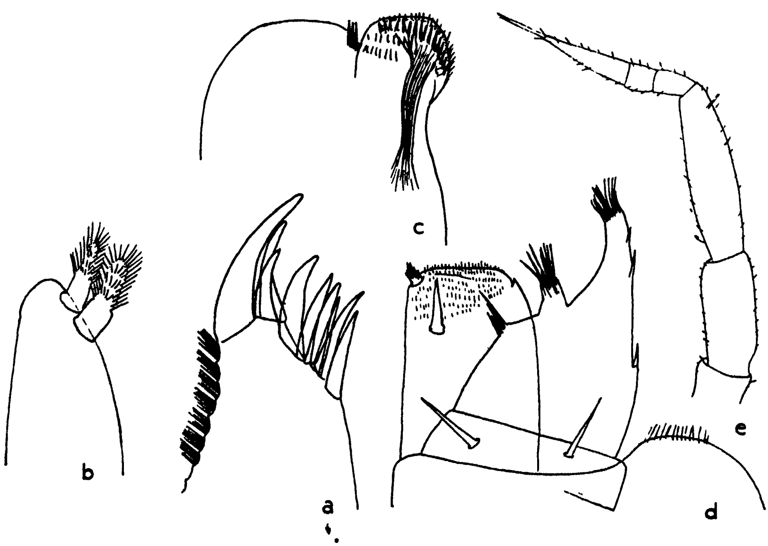

FIGURE 8.—*Cerberoides* (*Oniscomorphus*) *bicornis*: *a*, maxillula, outer endite; *b*, maxillula, inner endite; *c*, maxilla; *d*, maxillipede. *Cerberoides* (*Congloboniscus*) *brevicauda*; *e*, antenna.

Subgenus CONGLOBONISCUS, new subgenus

Head. Lateral lobes not pronounced but distinct; median lobe slight; frontal line and supra-antennal lines strong and high, whole head distinctly flattened antero-posteriorly as in conglobating forms of the "Armadillo" type. Postero-lateral angles of thoracic tergites absent. Pronotum wide.

Cerberoides (Congloboniscus) brevicauda, new species (figs. 8, *e*; 9). (For mouthparts see fig. 8, *a-d*.)

Females only. Length 4.5 mm., breadth 1.75 mm.

Shape, broad oval. Surface, smooth and minutely scaly. Color, in alcohol, yellow ground extensively mottled with brown pigment.

Head. Eyes small, 9 ocelli. Lateral lobes not very pronounced but indicated; median lobe slightly raised, profrons deeply hollowed under lobe; marginal line dips at slight angle below eye; frontal line distinct and raised; supra-antennal line very strongly marked, passing on each side to antennary tubercles, which form large blunt shelf-like protuberances over antennary sockets; post-frons slightly bulbous and high. Lateral lobes of clypeus moderately large and sickle-shaped.

Thorax. Hind margins of tergites sinuate; lateral margins rounded, no postero-lateral angles; pronotum about half breadth of tergite; dorsal surface of head and each tergite with well-marked longitudinal folds.

Abdomen. Very short; postero-lateral angles of thoracic tergite 7 greatly exceed hind border of 4 but just fail to pass the epimera; epimera of 1, 2, and 3 absent; hind margin of 5 horseshoe-shaped, enclosing telson which scarcely exceeds it. Telson, posterior margin bluntly triangulate, sides slightly emarginate; two thirds broader than long.

Appendages. Antenna: flagellum triarticulate, proximal articles short, distal more than twice as long as combined proximal. Mouthparts as described for *Philoscodillo* above. Pleopoda: rudimentary pseudo-tracheae present. Uropod: protopod broad and pear-shaped; exopod short, lanceolate, placed at narrow posterior extremity of protopod; endopod set above exopod nearly half of protopod, about same length as exopod.

Rapa: northeast ridge of Mangaoa Peak, alt. 1,000-1,100 ft., July 29, 1934 (Z).

This is the most modified member of the Oniscinae and exhibits as striking an adaptation to the rolling up habit as is found outside the "Armadillo" group.

SUBFAMILY PORCELLIONIINAE

Porcellio (Mesoporcellio) laevis Latreille.

Mangareva Islands: Akamaru, under half coconut, at sea level, May 30, 1934 (C).

Distributed sporadically throughout the Pacific islands.

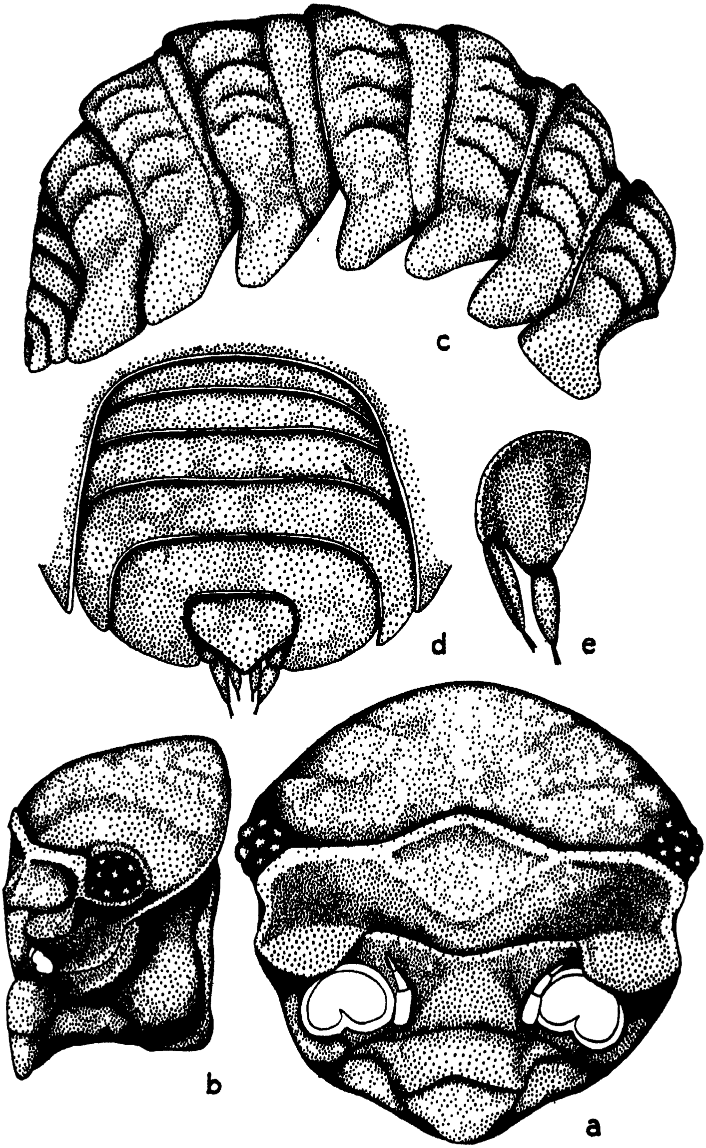

FIGURE 9.—*Cerberoides* (*Congloboniscus*) *brevicauda*, new species: *a*, head from front; *b*, head from side; *c*, thorax and abdomen from side; *d*, abdomen and telson from above; *e*, uropod.

Porcellio (Porcellio) scaber Latreille.

Rapa: near Area, alt. 10 ft., June 30, 1934 (Z); ravine above Area, alt. 378 ft., July 2, 1934 (F); Maitua, alt. 600-800 ft., July 2, 1934 (C, Z); north slope of Mount Ororangi, July 3, 1934 (C, Z); southeast valley, Mount Ororangi, alt. 600-700 ft., July 3, 1934 (Z); top Mount Ororangi, July 6, 1934 (F); northeast ridge of Mangaoa Peak, alt. 900-1,200 ft., July 6, 1934 (Z); northeast ridge of Mangaoa Peak, alt. 1,000-1,200 ft., July 25, 1934 (Z); northwest slopes of Mount Tautautu, alt. 700-800 ft., July 9, 1934 (Z); near Morongota, alt. 500-800 ft., July 11, 1934 (Z); Moio, alt. 900 ft., July 13, 1934 (F); Karapo Rahi Islet, alt. 100-300 ft., July 18, 1934 (Z); northeast slopes of Mount Tevaitahu, alt. 600-800 ft., July 8, 1934 (Z).

This is the first record of the typically European *Porcellio scaber* from the south Pacific islands, and, occurring in such large numbers on a single island, it has obviously been introduced accidentally and has prospered.

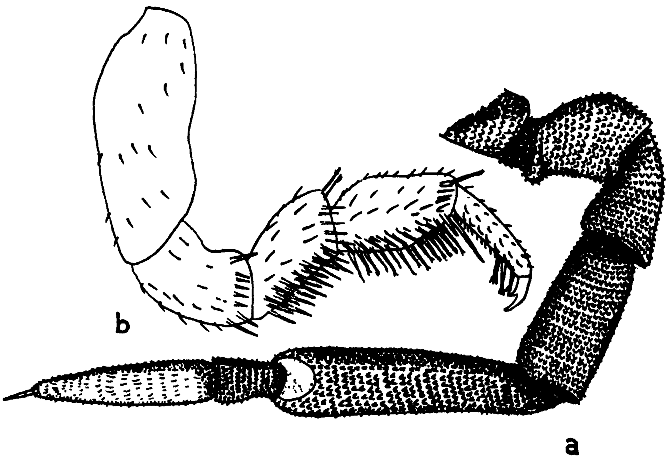

FIGURE 10.—*Porcellio* (*Heminagara*) *tahitiensis*: *a*, antenna; *b*, 1st peraeopod ♂.

Nagara (Heminagara) tahitiensis Jackson (fig. 10).

Mangareva Islands: Mangareva, Rikitea, May 31, 1934 (no collection label).

Austral Islands: Tubuai, Murivai, alt. 10 ft., Aug. 11, 1934 (Z); Maria, northeast islet, Sept. 6, 1934 (Z).

Society Islands: Raiatea, Tetaro Islet, alt. 3 ft., Oct. 4, 1934 (Z).

Christmas Island: Griegs Grove, alt. 3 ft., Oct. 21, 1934 (Z).

Described from Tahiti (4), this species is evidently more widely distributed than was suspected. The record from Christmas Island is, however, too wide for a comfortable credulity; there is no doubt about the identity of the specimens, but there may be legitimate suspicion as to the correctness of the locality.

All of these specimens, while agreeing in every other particular with the type, have fewer ocelli—16 to 17 as against 20. Females differ in no substantial characters from males. The antenna, which was missing in the type, is figured here, with the first peraeopod of the male. The antenna is short and strongly formed, the flagellum equals the fifth segment and its proximal article is one third the distal one. All pleopods have rudimentary pseudo-tracheae.

Porcellio (Porcellionides) pruinosus Brandt.

Fanning Island: Cable Station, under coral pebbles, April 21, 1934 (F).

Of world-wide distribution; it is surprising that this is the only record from this extensive collection.

Subfamily ARMADILLINAE

Spherillo (Spherillo) testudinalis Budde-Lund.

Mangareva Islands: Mangareva, at sea level, May 30, 1934 (F).

Austral Islands: Raivavae, Taraia Hill, Aug. 5, 1934 (C). Tubuai, Teraetu, west slope, Aug. 22, 1934 (C, D A).

Society Islands: Tahiti, Papeari, Tiupi Bay, March 19-21, 1934 (Z); Fautaua Valley, alt. 200 ft., May 7, 1934 (Z). Raiatea, Tetaro Island, Oct. 5, 1934 (C); Hureu Islet, Oct. 10, 1934 (C). Moorea, Faatoai Valley, alt. 100-300 ft., Sept. 23, 1934 (Z). Tahaa, east ridge of Mount Purauti, alt. 600-900 ft., Oct. 10, 1934 (Z). Meetia, under stones, alt. 500 ft., May 12, 1934 (C).

Spherillo (Spherillo) montivagus Budde-Lund.

Mangareva Islands: Mangareva, pass west of Rikitea, under moss and rocks, May 1934 (F); northeast slope of Mount Duff under rotten bark, alt. 300 ft., May 1934 (Z); Rikitea, May 25-26, 1934 (C); Gatavake, under stones and dead leaves, May 27, 1934 (C).

Pitcairn Island: south side, June 14, 1934 (Z).

Henderson Island: under dead leaves, alt. 100 ft., June 20, 1934 (F).

Rapa: southeast valley of Mount Ororangi, alt. 600-700 ft., July 3, 1934 (Z); Mount Tevaitahu, alt. 600-800 ft., Aug. 8, 1934 (Z).

Austral Islands: Raivavae, Mount Muatapu, Aug. 11, 1934 (F). Tubuai, Teraetu, west slope, Aug. 22, 1934 (C, D A).

Spherillo (Xestodillo) marquesarum Jackson.

Mangareva Islands: Mangareva, pass west of Rikitea, under moss and rocks (F).

Pitcairn Island, Middle Hill, June 14-15, 1934 (F).

Henderson Island, alt. 5 ft., in base of *Asplenium nidus,* June 21, 1937 (F).

Austral Islands: Raivavae, Hotuatua Islet, Aug. 11, 1934 (C, Z, W A). Rurutu, bluff north of Moerai, under trash, Aug. 25, 1934 (C); Mount Manureva, southwest slope, alt. 1,100 ft., Aug. 29, 1934 (Z). Rimatara, top of mountain, Sept. 5, 1934 (J).

Society Islands: Tahiti, Fautaua Valley, alt. 750 ft., May 7, 1934 (F); Taohiri, Mount Aorai Trail, alt. 3,500 ft., Sept. 12, 1934 (Z); Mount Aorai Trail, alt. 5,500-6,300 ft., Sept. 15, 1934 (Z); Papenoo Valley, under stones and in moss, alt. 1,500 ft., Sept. 16, 1934 (F) Moorea, Faatoai Valley, alt. 300 ft., Sept. 24, 1934 (Z).

Spherillo marquesarum var. **australis,** new variety.

Some of the specimens collected in the Austral Islands make a pronounced approach to *Spherillo montivagus* and have accordingly been given the rank of variety.

The groove on the tumid edge of the first tergite is less pronounced than in *S. marquesarum,* and the outer fold does not reach so far down; the exopod of the uropod is smaller; the flagellum of the antenna is very slender and the eyes are smaller (10 ocelli). All these characters show an approach to *S. montivagus.* The color tends to be paler except on the seventh tergite and head, which tend to retain the dark purple-brown in contrast to the yellowish body.

Austral Islands: Tubuai, Mount Taitaa, alt. 1,000 ft., Aug. 15, 1934 (Z); Mount Tavaetu, alt. 800 ft., Aug. 22, 1934 (Z); Mount Tavaetu, northeast slope, under stones, Aug. 22, 1934 (J); Mount Taitaa, southwest slope, alt. 1,200 ft., Aug. 23, 1934 (Z). Raivavae, Taraia Hill slope, under trash, Aug. 9, 1934 (Z); Hotuatua Islet,

alt. 15 ft., Aug. 11, 1934 (Z). Rurutu, Mount Manureva, southeast slope, alt. 1,100 ft., Aug. 30, 1934 (Z).

Cubaris murinus Brandt.

Mangareva Islands: Mangareva, northwest slope of Mount Duff, alt. 300 ft., *Hibiscus tiliaceus* trunk, May 23, 1934 (Z), May 26, 1934 (C); Rikitea, May 25, 1934 (C); sea level, May 30, 1934 (F); Gatavake, under stones and dead leaves, May 27, 1934 (C).

Austral Islands: Raivavae, near Unurau, Aug. 3, 1934 (Z); south slope of Pic Rouge, alt. 200-400 ft., Aug. 5, 1934 (Z); near Anatonu, alt. 10 ft., Aug. 12, 1934 (Z).

Rapa: Mount Taga, above watering place, July 27, 1934 (DA).

Society Islands: Tahiti, Mount Aorai Trail, alt. 5,500-5,600 ft., Oct. 14, 1934 (Z). Moorea, Faatoai Valley, Oct. 23, 1934 (C, K).

Fanning Island, Cable Station, under coral pebbles, April 21, 1934 (F); English Harbor, under coral shingle, April 22, 1934 (F).

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OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV November 5, 1938 Number 11

On the Genus Goniophyto Townsend, 1927, with Description of a New Species from Hawaii

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Sometime ago, Mr. E. H. Bryan, Jr., Curator of Collections, B. P. Bishop Museum, sent to me for study some determined specimens of *Sarcophaga* and abundant material of an interesting sarcophagid fly, apparently new to science. I found that it agreed most closely with the genus *Agria* Desv. (type: *Musca latifrons* Fallen). One specimen of this material was sent to C. H. T. Townsend, who wrote me as follows: " . . . a species near *Goniophyto* differing from that genus practically only by arista micro-pubescent, palpi gently clavate, 1 Pa, M3 nearly cubitulus. . . . The Hawaiian Sarcophagid may be referred to that genus (*Goniophyto*) as an atypic member."

Through the kindness of Walther Horn, I studied the holotype of *G. formosensis* Towns., genotype of *Goniophyto,* from the collection of the Deutsches Entomologisches Institut, Berlin-Dahlem. Comparing it with *G. bryani,* n. sp., I am still in doubt whether this latter can be placed in *Goniophyto,* because the shape of head is very different. The head of *G. formosensis* Towns., viewed from the side, is more or less quadrangular, because the antennae are very long. On the contrary, *G. bryani* has the front obliquely sloping down, because the antennae are much shorter. Notwithstanding, I provisionally include the new species in the genus *Goniophyto.*

As this species may have been introduced into Hawaii from the Oriental region, I compared it with the descriptions of some Oriental species (Senior-White, Rec. Ind. Mus., 26:257, 1924). *Leucomyia cinerea* Fabr. (synonym: *Sarcophila alba* Schin.) seems to be similar, but Townsend, in his redescription of *S. alba* Schin. (Ann. Mag.

Nat. Hist., X, 8: 377, 1931) does not mention the unusual enlargement of the second aristal joint, present in the new species.

Genus GONIOPHYTO Townsend, 1927

Towns., 1927, Ent. Mitt., 16:281.—1935, Man. Myiology, 2:176.

Resembling *Agria* Desv. mainly in the shape of male abdomen. First two aristal joints elongate. Fronto-orbital bristles proclinate in both sexes (sometimes minute in *G. bryani*, n. sp.). Costal spine strong. Fifth sternite entire in male. Abdomen of male truncate at apex, and first genital segment with two rows of bristles.

Goniophyto formosensis Towns., Ent. Mitt., 26: 281, 1927; (fig. 1).

Male: total length, 7.5 mm.

Front about 0.36 of head, frontal stripe 0.33 of front width above. Head silvery; frontal bristles about 6; two small proclinate fronto-orbital bristles present. Parafrontals with some hairs in whole length. Antennae grayish, second joint about 0.34 length of third and reaching 0.92 of the way to vibrissae. Arista pubescent, first two joints elongate. Palpi light brown. Ocellar and outer vertical bristles present. Three to four rows of black bristles on back of head.

Thorax gray with three indistinct black stripes. Three pairs of postsutural dorsocentral bristles, two anterior dorsocentrals; anterior acrostichals very weak, scarcely differentiated from vestiture of praescutum; posterior acrostichals absent; humerals 3; notopleurals 2, sternopleurals 2, hypopleurals 4, mesopleurals 4; posthumeral 1; intralars 2, supralar postsuturals 3, and presutural 1. Scutellum with two pairs of marginals and a small discal, no apical bristles. Propleura and prosternum bare.

Abdomen silvery pollinose, blackish on hind margin of segments 3 to 5. Second segment with only one lateral bristle, third and fourth with a median marginal, fifth with a row of about 16. Fifth sternite entire. Genital segments black, the first with two pairs of basal bristles and a preapical pair; second segment with black hairs. Forceps reddish, covered with short yellow pile, except in the extreme apex and with black hairs which are very long at base; viewed from behind they diverge slightly to the apex. Accessory plate shining yellow, about as long as forceps, with black bristles at apex. Posterior claspers very small and with a very long bristle at apex. Anterior claspers shining reddish yellow and greatly developed. Penis very long and thin, directed backward.

Legs black, middle femora without comb, middle tibia with three bristles on the outer front side. Hind femora with a complete row of dorsal bristles and three bristles below.

Wings hyaline: *r* 1 bare, *r* 4-5 with about five bristles, reaching two thirds of the way to crossvein. Costal spine strong.

Redescribed from the holotype male, Anping, Formosa, V.1912 H. Sauter, in Berlin-Dahlem (Deutsch. Ent. Inst.).

Goniophyto bryani, n. sp. (fig. 2).

Differs from the genotype in shape of head and male genitalia.

Male: total length, 3.5-8 mm.

Front about 0.33 of head, frontal stripe 0.38 of front width above. Head silvery, frontal bristles 6 to 8; two small proclinate fronto-orbitals present, about as long as ocellars (in some specimens very minute). Parafrontals with sparse hairs in whole length. Antennae grayish, second joint about 0.47 length of third, reaching 0.71 of the way to vibrissae. Arista pubescent, first two joints elongate. Palpi yellow-brown. Ocellar and outer vertical bristles present. Back of head with four to five rows of postocular cilia.

Thorax gray with indistinct stripes. Three postsutural dorsocentral bristles, two anterior ones; anterior acrostichals very weak, prescutellars present; humer-

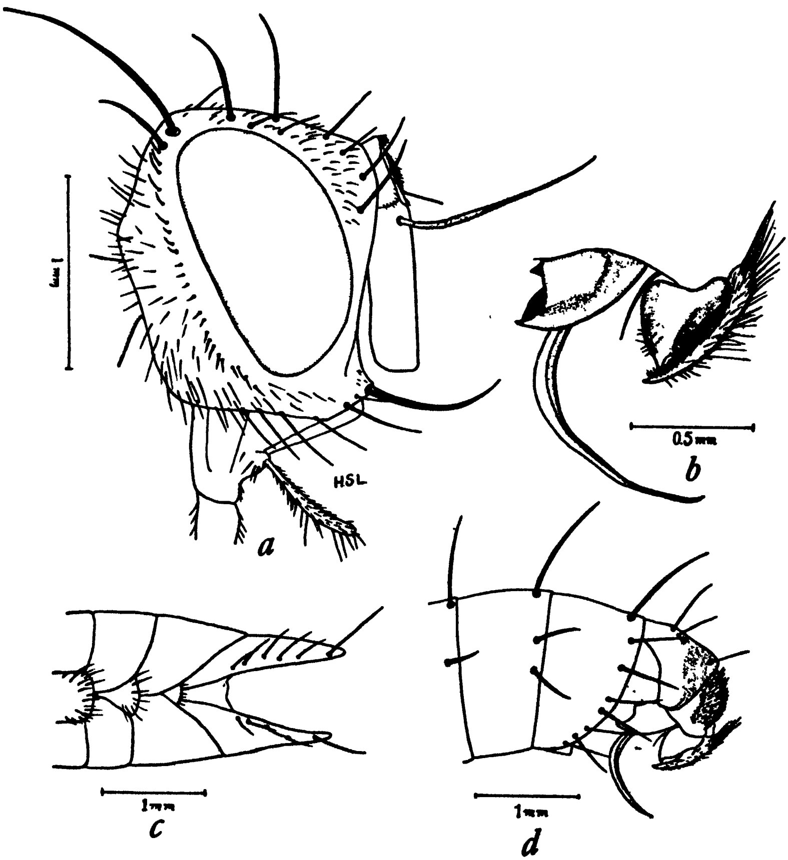

FIGURE 1.—*Goniophyto formosensis*: *a*, head of male, lateral view; *b*, male terminalia; *c*, male abdomen, ventral view; *d*, male abdomen, lateral view.

als 3, posthumeral 1, intralars 2, supralar postsuturals 3, and 1 presutural; notopleurals 2, mesopleurals 5, sternopleurals 2, hypopleurals 4 to 5. Propleura and presternum bare. Scutellum with two pairs of marginal bristles, one small preapical pair and no apical.

Abdomen silvery pollinose, black on posterior margin of segments. Second segment with lateral bristle only, third and fourth with strong median marginal and fifth with a row of about 15 marginals. Fifth sternite entire. Genital segments reddish black, the first with four basal bristles and two preapicals, the second with only black hairs. Penis with two apical lobes.

Legs black, middle femora without comb, middle tibia with two antero-dorsal bristles. Hind femora with a complete row of dorsal bristles and four to five bristles below.

Wings hyaline, costal spine strong, *r* 4-5 with bristles reaching two thirds of way to crossvein. The small specimens have apical cell closed at costal border.

Female: length, 4-7 mm.

Front about 0.35 of head width, frontal stripe 0.48 of front width. Proclinate fronto-orbital bristles more developed than in male.

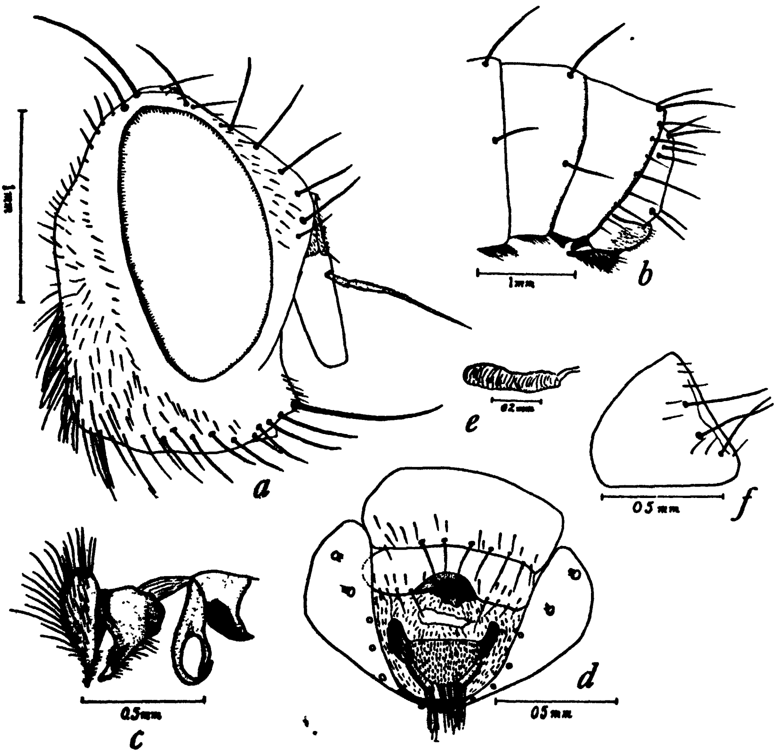

FIGURE 2.—*Goniophyto bryani*: *a*, head of male, lateral view; *b*, last segment of male abdomen; *c*, male terminalia; *d*, female terminalia, ventral view; *e*, spermatheca; *f*. female fifth stenite.

Holotype male and allotype female from Hawaiian islands, Nihoa Island, June 13, 1923, E. H. Bryan, Jr.

Paratypes as follows: Leeward Hawaiian islands: Nihoa Island, 1 male and 2 females, June 24, 1923, Bryan; Necker Island, 1 male and 5 females, June 17-20, 1923, Bryan; French Frigate Shoal, 3 males and 5 females, June 24, 1923, Bryan; Pearl and Hermes Reef, 4 females, April 26, 1923, Fullaway; Midway Island, 3 females, April 1923, Fullaway; Kure (Ocean) Island, 2 females, June 1923, Fullaway; Johnston Island, 5 males and 9 females, June 18, 1923, Bryan.

The holotype, allotype, and 31 paratypes are stored in B. P. Bishop Museum; 4 male and 4 female paratypes are in the Instituto de Biologia Vegetal (Rio de Janeiro); and 1 male and 1 female paratype are in Deutsches Entomologisches Institut (Berlin-Dahlem).

I take pleasure in naming the new species after E. H. Bryan, Jr.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV December 9, 1938 Number 12

Ciidae of Southeastern Polynesia[1] (Coleoptera)

By ELWOOD C. ZIMMERMAN

INTRODUCTION

Scope

This paper is founded on the collections made by me while on the Mangarevan Expedition to southeastern Polynesia in 1934. It includes all of the known Ciidae from Oceania east of Samoa and exclusive of Hawaii. Two genera, twelve species, and one subspecies are included; of these, one genus, six species, and one subspecies are described as new.

The collection made by the Expedition is composed of 550 specimens. In addition to this collection four specimens furnishing new data and the types or specimens compared with the types of all the previously known species were studied from material in Bernice P. Bishop Museum. The Mangarevan Expedition procured four of the six previously described species and obtained new host and distributional data for these. The types and the collection are stored in Bishop Museum.

Previous Work

The first report including Ciidae from southeastern Polynesia was written by Dr. K. G. Blair (Ann. Mag. Nat. Hist. IX, **20**:166, 1927) and described three new species collected in the Marquesas by the St. George Expedition. In 1932, Dr. Blair described a fourth Marquesan species (Bishop Mus., Bull. **98**: 242), and in 1934 he described two more Marquesan species (Bishop Mus., Bull **114**: 294)

[1] Mangarevan Expedition publication 27.

and gave a key for the separation of the six Marquesan species. These last three species were collected by the Pacific Entomological Survey.

Analysis of the Fauna

Little is known of the Ciidae of Oceania. With the exception of Hawaii, which is the most thoroughly explored region in Polynesia, our knowledge does not enable us to present the true state of the developments of the faunas of the many islands and archipelagos of the Pacific. It is probably true, however, that the Ciidae have not speciated to any great extent in southeastern Polynesia, and that in comparison with the Curculionidae, for example, they are rather poorly represented and show much less evolution. The ciid fauna of southeastern Polynesia is, I believe, much younger than that of Hawaii. None of the species described from the region has yet been found elsewhere, but it is probable that some of them may be found in the islands to the west. Seven species and one subspecies are confined to single islands; five species have been found in two to five archipelagos. At least part of this mono-insular endemism may be broken down when more specialized collecting is done. However, there are a few species from Rapa, the Marquesas, and the Society Islands that are evidently precinctive developments and are restricted to the islands from which they have been described.

The following table will show the developments of the eastern Oceanic ciid faunas as ascertained from described species.

	S.E. Polynesia	Hawaii	Samoa	Fiji	New Caledonia	New Zealand
Number of genera	2	2	2	1	2	2
Number of species	12	48	3	1	9	20

This table better displays our ignorance of the faunas than it does the true development of the Ciidae. For example, one species of *Ceracis* was described from Fiji in 1881, and no Fijian Ciidae have been described since. However, the numerous islands of that archipelago undoubtedly have comparatively well-developed ciid faunas, for I have seen undescribed species. I have no records of Ciidae from the great archipelagos of New Hebrides and the Solomons, but they most

certainly are well supplied with representatives of a complex ciid fauna. No Ciidae have been described from the whole of Micronesia, yet there are representatives of several genera before me. These small, obscure insects, which are difficult to handle, have generally been neglected in collections and studies of Oceanic insects.

In Oceania, east of Australia and New Guinea, the following six genera have been found: *Apterocis, Ceracis, Cis, Ennearthron, Scolytocis* and *Polynesicis. Apterocis* has evolved in Hawaii and is not found elsewhere. *Scolytocis* is represented by a single Samoan species. *Polynesicis* is also monotypic and is probably a rather recent offshoot of *Cis. Cis, Ennearthron* and *Ceracis* are found around the world. *Cis* is the largest and most widespread genus of the family. Although *Ennearthron* and *Ceracis* are found in both the Old and New Worlds, *Ennearthron* has been reported only from New Caledonia and New Zealand and *Ceracis* only from Fiji in the vast region under discussion.

Biology

Ciids are fungicolous. Among those that I collected in southeastern Polynesia two major types of habit can be outlined: 1, species which are strongly gregarious and inhabit shelf fungi in large numbers; 2, species which are not strongly gregarious and are found singly or in associations of but few individuals feeding upon fungi on or beneath the bark of dead twigs, limbs or trunks of shrubs and trees or dead fern fronds. It is not unusual to find more than one species among the gregarious forms living in the same fungus. From one colony of fungus growing on a dead stump at Rapa I dissected 340 specimens of three species of *Cis*. I collected only part of the total number of adult inhabitants of the fungus; there were probably several times as many as I collected in addition to a large number of larvae and pupae. The larvae and adults of the three species were feeding side by side and their pupal cells were contiguous. From this colony I took 205 *Cis furicollis,* 103 *Cis marquesanus* and 32 *Cis rapaae.* In contrast to such gregarious species are species having habits similar to *Cis tahitiensis, Cis montevagus,* and *Cis arbustensis,* specimens of which I beat singly or in small numbers from a variety of shrubs and some ferns.

The larvae have legs, are elongate in form, the ultimate tergite usually bears a pair of protuberances or spines, and there is a protuberance on the ultimate ventrite.

List of Species

1. Cis bisetosus Blair
   Marquesas
2. Cis rapaae, new species
   Rapa
3. Cis uapouae, new species
   Rapa
4. Cis furicollis Blair
   Marquesas, Rapa
5. Cis collenettei Blair
   Marquesas, Society Islands
6. Cis tahitiensis, new species
   Tahiti
7. Cis montevagus, new species
   Tahiti
8. Cis arbustensis, new species
   Rapa
9. Cis adamsoni Blair
   Marquesas
10. Cis cheesmanae Blair
    Marquesas, Society Islands
11. Cis marquesanus marquesanus Blair
    Marquesas, Tuamotu Archipelago, Mangareva, Rapa and Society Islands

11a. Cis marquesanus merytae, new subspecies
    Rapa

12. Polynesicis hirsutus, new genus, new species
    Rapa and Rurutu

Key to the Genera

1. Antennae 10-segmented .... **Cis.**
2. Antennae 9-segmented .... **Polynesicis.**

Genus CIS Latreille, 1796

Key to the Species

1. Derm predominantly yellowish and usually conspicuously bicolored, never uniformly brownish or black 2
   Derm never bicolored, concolorous, always reddish brown or nearly or quite black 3

2(1). Dorsal setae of two types: one type long, erect and black or almost so, intermixed with shorter inclined, golden setae; dark marks of the dorsum not strongly marked; underside pale; Marquesas .... **Cis bisetosus.**
   Dorsal setae very dense, of one type only, very fine, long, erect and entirely pale; dark dorsal marks black or almost so and sharply defined and conspicuous to the unaided eye; under side dark; Rapa .... **Cis rapaae.**

3(1). Dorsal pubescence long, erect, conspicuous, hairlike; a coarsely punctured black species........ **Cis uapouae.**

Dorsal pubescence short or very short, usually inconspicuous, often hardly discernible or apparently absent, never erect and conspicuous 4

4(3). Apical margin of the pronotum with two large, conspicuous divergent protuberances in the male; apical and lateral margins of the pronotum forming a very broad angle, almost continuous in both sexes (fig. 1, *h-i*)........ **Cis furicollis.**

Apical pronotal margin simple in both sexes, without teeth or protuberances, apical and lateral margins forming a distinct angle of about 135° (fig. 1, *f-g*)........ 5

5(4). Length 2-2.75 mm.; a large, shiny, very dark or quite black, minutely punctate species........ **Cis collenettei.**

Usually about 1.5 mm. long, never more than 1.8 mm. long........ 6

6(5). Prothorax large, distinctly more than half as long as the elytra (1.4:2)........ **Cis tahitiensis.**

Prothorax never distinctly more than half as long as the elytra, usually less than half as long, rarely very slightly more than half as long........ 7

7(6). Lateral carina of the elytra forming a distinct angle with the basal margin as in figure 1, *f*........ 8

Lateral carina of the elytra rounded at its junction with the basal carina, not angulate, figure 1, *g*........ 9

8(7). Prothorax but moderately reticulate, the interstices usually appearing somewhat shiny, not appearing rough and asperate but comparatively smooth, the individual punctures distinct; elytra moderately or conspicuously shiny, the setae minute, erect, those along the dorsum appearing very short and not overlapping when viewed from the side; Tahiti........ **Cis montevagus.**

Prothorax minutely but deeply and coarsely reticulate, individual punctures distinct, entire surface dull and appearing minutely granulate or minutely asperate; elytra comparatively dull, dorsal setae recurved and usually appearing to overlap one another when viewed from the side; Rapa........ **Cis arbustensis.**

9(7). Pronotum coarsely reticulate throughout, dull but with the reticulation giving prismatic reflections, lateral carina not visible from above; a small black species about 1.25 mm. long........ **Cis adamsoni.**

Pronotum either shiny and inconspicuously alutaceous or but finely reticulate, the lateral carinae visible throughout most of their lengths from above; derm usually reddish brown........ 10

10(9). Discal elytral setae microscopical, hardly discernible even under high magnification and appearing as minute specks, not obviously elongate; a stout, shiny species with the outline of the body distinctly convex and not subparallel-sided and with the elytra fully three fourths as broad as long........ **Cis cheesmanae.**

Discal elytral setae visible under moderate magnification, short and fine but distinctly elongate and hairlike; body subparallel-sided, elytra distinctly less than three fourths as broad as long........ 11

11(10). Dorsum obviously shiny, the interstices between the prothoracic and elytral punctures not so coarsely reticulate as to give a mat surface, but shiny........ **Cis marquesanus.**

Dorsum dull, the interstices between the prothoracic and elytral punctures minutely and very densely reticulate, but the reticulation coarse enough to give the entire surface a mat appearance..**Cis marquesanus merytae.**

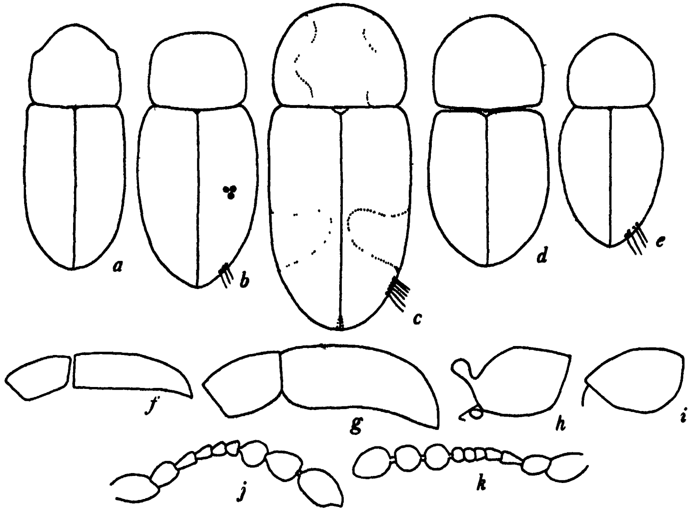

FIGURE 1.—Features of Ciidae. *a, Cis montevagus; b, Cis uapouae; c, Cis rapaae; d, Cis tahitiensis; e, Polynesicis hirsutus; f, Cis arbustensis; g, Cis marquesanus merytae; h,* lateral outline of prothorax of *Cis furicollis,* male; *i,* same, female; *j,* antenna of *Polynesicis hirsutus; k,* antenna of *Cis marquesanus.*

1. Cis bisetosus Blair: B. P. Bishop Mus., Bull. 114: 295, fig. 5, 1934.

Derm pale stramineous, not dark below; pronotum infuscated on the sides and apex of the disk; elytra infuscated along the sides, with a dark spot at the middle of each elytron coalescing postero-laterally with an oblique extension of the lateral infuscation, the suture infuscate at the apex, and with a faint spot behind the base of each elytron. *Setae* long, erect, hairlike, rather dense, consisting of two types: one long erect, black and most numerous; the other shorter, rather serially arranged, inclined, golden and less abundant.

Head with the crown and front almost vertical, not concealed by the pronotum, the anterior margin slightly raised; setose. *Prothorax* transverse (6.2:5), strongly rounded on the sides and apex; the lateral carina visible throughout its length from above, its posterior angle broadly rounded, thence almost straight to the junction with the apical margin and there forming a distinct angle of about 135° with the apical margin; disk densely and conspicuously punctate throughout, the punctures distinct, separated by distances not greater than their diameters, the interstices glistening. *Elytra* subparallel-sided to the declivity, hardly broader than the prothorax, three fifths as broad as long, slightly more than twice as long as the prothorax; very densely, rather confluently punctate throughout. *Underside* densely and minutely punctate, finely setose. Length, 2 mm.; breadth, 0.85 mm.

Marquesas: Fatuhiva Island.

The unique male holotype, in Bishop Museum, beaten from *Metrosideros,* is the only specimen of this pale species known. The head and prothorax have neither teeth nor protuberances.

2. **Cis rapaae,** new species (fig. 1, *c*).

Dermal coloration in mature specimens is as follows: prothorax and elytra pale yellow to rather dark yellowish brown, the pronotum very dark brown or black on the sides, the disk the same color as the elytra from base to apex; elytra dark brown or black along the lateral margins and with an outstanding, antero-mesad oblique extension of the dark color on each elytron that reaches slightly past the middle and does not quite reach the suture, the suture slightly or conspicuously darker at the apex; head and sternum very dark brown or black; venter brown, slightly paler than the sternum; legs brown or reddish brown; dorsal setae dense, long, erect, very fine and hairlike, golden.

Head with the crown and front very steep or almost vertical, not concealed by the pronotum, somewhat flattened between and above the eyes; densely punctate, the punctures not separated by distances greater than their diameters; the fore margin slightly upturned on either side of the clypeus in both sexes, the outline, together with the clypeus, arcuate. *Antennae* with the first segment globose, one third longer than the second which is slightly longer than broad, broader at the base than apex and about as long as three which is as long as four plus half of five, four about as long as five plus six, five to seven transverse, eight, nine and ten subequal in breadth and forming a symmetrical club, eight and nine subequal, ten longer than broad, and longer than nine, triangularly pointed in the apical half. *Prothorax* slightly broader than long (1.6:1.4), broadly rounded at the sides and apex, basal margin slightly convex; lateral carina with the basal angle broadly rounded, thence but slightly arcuate to the apical margin where the junction forms a distinct angle of about 135°; densely and minutely punctate, the punctures distinct, separated by glistening interstices not greater in breadth than their diameters. *Elytra* subparallel-sided to the declivity, distinctly broader than the prothorax, two thirds as broad as long, slightly more than twice as long as the prothorax; punctuation rather similar to that of the prothorax. *Legs* with the femora broad and compressed, finely setose. *Sternum* densely and finely punctate, coarsely reticulate; finely setose; the fore coxae separated by a strongly developed, somewhat protuberant intercoxal piece about half as broad as a coxa, mesocoxae only half so widely separated. *Venter* finely and densely punctate, coarsely reticulate, setae long and hairlike, comparatively dense; first ventrite with a small median tubercle in the male, simple in the female. Length, 1.8-2.3 mm.; breadth, 0.8-1.1 mm.

Rapa. Holotype male, allotype female, and 31 paratypes dissected by me from dead shelf fungi on isolated stump, west slope of Mount Taga, elevation 700 feet, July 26, 1934.

This pretty species is allied to *Cis bisetosus* Blair, and can be distinguished from that species by its darker derm, more definite markings, and by its single type of hairlike pubescence.

There is considerable variation in color in the series; some specimens are pale yellow, others are rather dark yellowish brown. On

immature specimens the darker markings on the underside sometimes show a slight greenish cast where the pigment did not have sufficient time to fully darken before the insects were killed.

3. Cis uapouae, new species (fig. 1, *b*).

Female. Derm black throughout, rather shiny, but with the appendages reddish brown; dorsal pubescence rather dense, long, hairlike and erect, with a golden glint. *Head* with the front and crown sloping but not concealed by the pronotum, the anterior margin but slightly upturned, subtruncate in front; densely punctate, the punctures distinct, round, and rather deep, their interstices not broader than their diameters. *Antennae* with the first segment one third longer and broader than the second which is slightly shorter than three, three one fourth longer than four, four almost as long as five plus six, five, six and seven subequal in length and each successively slightly broader, eight and nine subequal, but eight not quite so broad as nine, ten about one third longer than nine, ovoid and sharply pointed. *Prothorax* transverse (1.4:1.1), base convex, arcuate on the sides, broadly rounded at the apex, the sides joining the apical margin in a rounded, obtuse angle; lateral carina not visible from above, almost obsolete, very slightly arcuate from base to apex and forming a distinct angle of about 100° with the apical margin; densely punctate, the punctures moderately large, round and well impressed, their interstices not much broader than half their diameters, rather smooth, shiny, finely alutaceous; pubescence rather dense and similar to that on the elytra. *Elytra* conjointly broadly emarginate at the base, slightly arcuate near the base on the sides, and thence roundly narrowing to the apex, over three fifths as broad as long and two and one half times as long as the prothorax; densely punctate throughout, the punctures similar to those on the pronotum or slightly coarser and closer. *Sternum* densely and rather coarsely punctate and coarsely reticulate throughout, fore coxae separated by about three fourths of the breadth of a coxa, intercoxal process of the mesosternum about half as broad as that of the pronotum. *Venter* densely punctate and coarsely reticulate throughout, the setae long and hairlike, prostrate or slightly inclined. Length, 1.8 mm.; breadth, 0.8 mm.

Marquesas: Uapou Island. Holotype female beaten from *Bidens lantanoides* at Tekohepu Summit, elevation 3,000 feet, November 28, 1931, by G. LeBronnec.

This species cannot easily be confused with any of the other species of *Cis* from southeastern Polynesia because of its black color and hirsute dorsum.

4. Cis furicollis Blair: B. P. Bishop Mus., Bull. **114**:295, fig. 4, 1934; (fig. 1, *h-i*).

Derm castaneous, moderately shiny; dorsal setae minute and hardly discernible.

Head with the crown and front mostly concealed by the prothorax, appearing horizontal and concave above in the male when viewed from the side, apical margin continuously arcuate and narrowly upturned in the female, broadly upturned and slightly emarginate in the male, angles at the sides of the clypeus distinct. *Antennae* with the first segment, excluding its segmentlike basal stalk, robust,

one third longer and almost twice as broad as the second, two ovoid, broader at the apex than base, one fourth longer than three and about twice as broad, three as long as four plus half of five, four somewhat larger than five, five to seven successively slightly more transverse, eight and nine subcircular in outline, nine slightly less so than eight, ten slightly longer than nine, acutely pointed. *Prothorax* slightly transverse, excluding the protuberances of the male; simple and hoodlike at the apex in the female but with two conspicuous, strongly developed, divergent, apical "horns" on the male; the sexes, therefore, easily separated with the unaided eyes; lateral carina hidden from above, basal angle broadly rounded, almost continuously arcuate with the apical margin and not forming a distinct angle; densely and minutely punctate, the interstices finely alutaceous, as broad or slightly broader than the punctures. *Elytra* almost three fourths as broad as long, somewhat less than twice as long as the prothorax, densely punctate throughout, the punctures somewhat coarser than those on the pronotum. *Sternum* with the prosternum not longer before the coxae than a fore coxa, the fore coxae very narrowly separated, the prosternal process between them thin and keel-like, mid and hind coxae subequally separated, and but slightly more separated than the fore coxae. *Venter,* as the sternum, reticulate and indistinctly punctate. Length, 1.5-2.0 mm.; breadth, 0.6-0.8 mm.

Rapa and Marquesas Islands.

Heretofore this species has been known from a unique pair collected from *Crossostyles biflora* on Hivaoa, Marquesas Islands. On Rapa I dissected 205 specimens from dead shelf fungi growing on a stump on the west slope of Mount Taga, elevation 700 feet, July 26, 1934.

The male holotype in Bishop Museum, figured by Blair, is a small specimen on which the pronotal "horns" are rather poorly developed. The majority of specimens in the series have these processes much larger and more conspicuous.

This is the only known species in southeastern Polynesia in which the males have apical teeth or horns on the prothorax. For this reason the species may be easily recognized.

5. **Cis collenettei** Blair: Ann. Mag. Nat. Hist. IX, **20**:166, 1927.

Derm dark brown to black, moderately shiny with the appendages and often the underside reddish brown; dorsal setae microscopical and hardly discernible.

Head with the crown and front fully exposed, not hidden by the prothorax, each side of the anterior margin slightly upturned to form an obtuse lobe between the eye and clypeus and equally developed in both sexes; finely alutaceous, evidently impunctate; without setae. *Antennae* with the first segment, excluding the basal peduncle, subcylindrical, but rather oval in outline, broader at the apex than base, twice as long as broad, two fifths longer than the second, two ovate, about three fourths as broad as one, three fifths as broad as long, slightly shorter than three which is slightly longer than four, four as long as five plus half of six, six as long as broad, seven transverse, eight and nine subequal in size and shape, ten as long as nine plus half of eight. *Prothorax* strongly transverse (2.2:1.6), broadly rounded on the sides and apex which is simple in both sexes;

the lateral carina strongly developed and visible throughout its length from above, the basal angle distinct and but slightly greater than 90°, not rounded off, thence but slightly arcuate to the distal margin where the angle is distinct and only slightly greater than 90°; finely alutaceous, densely and very minutely punctate. *Elytra* somewhat more than two thirds as broad as long, slightly more than twice as long as the prothorax; sculpture rather similar to that of the pronotum; the lateral carina forming a rather distinct obtuse angle with the basal carina. *Sternum* with the fore coxae separated by slightly more than half the breadth of a coxa; the intercoxal process of the prosternum almost twice as broad as that of the mesosternum; the sternum reticulate, minutely punctate, the punctures bearing small setae. *Venter* sculptured as the sternum; the first ventrite simple in the female but with a raised, round, median, pilose area, the middle of which is sunk. Length, 2.0-2.75 mm.; breadth, 1.0-1.25 mm.

Society, Austral and Marquesas Islands.

Heretofore this species has been recorded from Uapou and Hivaoa in the Marquesas and Tahiti and Moorea in the Society Islands. I collected 17 specimens as follows. Society Islands: Tahiti, 3 specimens found beneath dead bark on fence posts at Arihiri, Pare, March 8, 1934; Moorea, 9 specimens dug from beneath dead bark of a dead limb of *Hibiscus tiliaceus* in Faatoai Valley, elevation 200-300 feet, September 23, 1934. Austral Islands: Rurutu, 5 specimens dissected from dead *Piper* stems on the southwest slope of Mount Manureva, elevation 1,000 feet, August 25, 1934.

This rather widely distributed species is probably a comparatively modern introduction to the fauna. It will undoubtedly be found on most of the high islands of southeastern Polynesia and perhaps has its home farther to the west.

This species is one of the most easily recognized of the family in southeastern Polynesia, for it is larger than any of the other species. However, small individuals may be smaller than the largest specimens of *Cis rapaae,* but that species is hirsute and bicolored.

6. **Cis tahitiensis,** new species (fig. 1, *d*).

Derm black with an aenescent cast, the tarsi usually paler, and the antennae often yellowish with the three segments of the club dark; dorsal setae prostrate, short but distinct and rather hairlike, very fine.

Head with either the crown rather well exposed or hidden by the pronotum to between the eyes; coarsely and conspicuously reticulate, indistinctly punctate, finely setose; the anterior margin hardly upturned in either sex, inconspicuous and without teeth. *Antennae* with the first segment but slightly longer than broad, longer on its outer side than the inner side, about one third longer and two fifths broader than the second which is obovate, broader before than beyond the middle and as long as three, three about as long as four plus half of five, four fully as broad as three and as long as five plus six, five to seven moniliform and subequal, eight apparently slightly transverse, as long as seven plus half of six,

truncate at the apex, nine similarly shaped, truncate at the apex but somewhat longer and two fifths broader than eight, ten as broad as nine, almost as broad as long, with a small acute point. *Prothorax* large and stout, distinctly transverse (2.6:3.2), distinctly more than half as long as the elytra (2.5:4); lateral carina not visible from above, its basal angle well rounded, thence arcuate to the apical margin where the angle is rounded, but with the apical margin making an angle of about 135° with the horizontal plane of the prothorax; dorsum finely to coarsely reticulate, densely, but usually rather shallowly punctate, the punctures not separated by interstices broader than their diameters. *Elytra* fully three fourths as broad as long, arcuate on the sides; the lateral carina making a distinct obtuse angle with the basal carina, the angle occasionally rounded, but distinct; sculpture rather similar to that of the pronotum or somewhat less coarse. *Legs* coarsely reticulate; the femora thick, shallowly, distally sulcate below. *Sternum* very coarsely reticulate; the fore coxae separated by about half the breadth of a coxa by a prominent, slightly protuberant, straight-sided process, the fore coxal cavities laterally triangular; mesocoxae narrowly separated, the intercoxal process only about one third as broad as that between the metacoxae. *Venter* coarsely reticulate, sparsely setose, indistinctly punctate; the first ventrite about as long or slightly longer than the three following ventrites together along the median line, simple in the female but with an oval, median, setose, craterlike fovea in the male. Length, 1.5-1.6 mm.; breadth, 0.7-0.8 mm.

Society Islands: Tahiti, holotype male, allotype female, and three paratypes beaten from shrubs on Mount Aorai Trail, elevation 3,500-4,500 feet, September 13, 1934; three paratypes with the same data but two beaten from ferns and one from *Metrosideros*; one paratype beaten from *Weinmannia,* on the same trail, elevation 4,500-5,500 feet, September 14; one paratype and one dissected specimen beaten from *Metrosideros* on the same trail, elevation 4,500-5,500 feet, September 14, 1934. The eleven specimens were collected by me.

This species most closely resembles *Cis montevagus* but has a larger prothorax, the lateral margin of which is concealed from above instead of being visible throughout its length. No wings could be found upon dissection.

7. **Cis montevagus,** new species (fig. 1, *a*).

Derm black in mature specimens, slightly shiny, the appendages paler; dorsal setae very small but distinct, appearing as elongate, yellowish or iridescent specks.

Head exposed or covered to between the eyes by the pronotum; coarsely reticulate, minutely punctate, sparsely setose; front somewhat flattened; the anterior margin narrowly but distinctly and equally upturned in both sexes, with a simple arcuate lobe on either side of the clypeus and without teeth. Antennae with the first segment asymmetrical, about as broad as long on its broader side, as long as two plus half of three, fully one fourth broader than two which is broadest in the basal half and as broad as long and slightly shorter than three, three as long as four plus half of five, four as long as five plus half of six, five to seven successively slightly shorter, eight and nine subequal in size and shape, apically truncate, ten ovoid, acutely pointed at the apex and as long as nine plus

half of eight. *Prothorax* slightly transverse (2.6:2.3), the lateral carinae broadly and completely exposed throughout their lengths from above, the lateral outline but slightly arcuate and in part straight; the lateral carina forming a distinct obtuse or slightly rounded angle with the base, thence almost straight to the apex where the angle is distinct and of about 135°; disk finely to rather coarsely reticulate, minutely, but distinctly punctate throughout, the punctures not separated by interstices greater than their diameters. *Elytra* subparallel-sided in the basal two thirds, three fourths as broad as long and just twice as long as the prothorax; the lateral carina forming a distinct obtuse but almost right angle with the base; base with a vague inconspicuous and feebly developed callosity a short distance above the point of the junction of the lateral prothorax carina with the base; densely and minutely punctate throughout. *Legs* with the femora broad and sulcate below in at least the distal half. *Sternum* coarsely reticulate, minutely punctate; the fore coxae separated by a prominent intercoxal process for two thirds the breadth of a coxa, the cavities subtriangular, mesocoxae only about half so broadly separated as the fore coxae. *Venter* with the sculpture similar to that of the metasternum; the first ventrite simple in the female and with a small, obscure median setose fovea in the male. Length, 1.5 mm.; breadth, 0.75 mm.

Society Islands: Tahiti, holotype female and one female paratype beaten from shrubs and allotype male beaten from ferns on Mount Aorai Trail, elevation 3,500-4,500 feet, September 13, 1934. The three specimens were collected by me. The male is somewhat immature, and, therefore, a mature female with extended ovipositor is designated as the holotype.

This species is evidently allied to *Cis tahitiensis,* but the smaller, differently shaped prothorax with its broadly exposed lateral carinae will serve to distinguish the species.

8. **Cis arbustensis,** new species (fig. 1, *f*).

Derm black, occasionally with a slight aeneous cast, with the tarsi and antennae, exclusive of the club, yellowish or reddish brown, the dorsum comparatively dull and with the elytra somewhat more shiny than the pronotum; dorsal setae distinct and conspicuous, prostrate or inclined, fine and hairlike, white with iridescent reflections.

Head exposed or concealed to between the eyes by the pronotum, very coarsely reticulate, sparsely and inconspicuously setose, evidently impunctate, the front somewhat depressed; the anterior margin very narrow and not conspicuously upturned, flanged nor toothed in either sex. *Antennae* with the first segment ovate, one fourth longer than broad, one fourth longer and one third broader than two, two one third longer than broad, three as long as four plus half of five, four broader than three and longer than five, six about as broad as four and larger than either five or seven, eight and nine trapezoidal, eight one third broader than long, one third shorter and one fourth narrower than nine, ten broadly ovoid, acutely pointed, almost as long as eight plus nine. *Prothorax* slightly transverse (2.2:2), rather evenly arcuate on the sides; the lateral carina visible throughout part or all of its length from above, its basal angle rounded thence slightly arcuate, occasionally almost straight, to the apex where the angle is very distinct but

obtuse and of about 135°; dorsum usually very coarsely reticulate and densely punctate throughout, the punctures, in certain lights, giving the impression of the disk being asperate; each puncture bearing an inclined, rather conspicuous seta. *Elytra* broadly arcuate on the sides, five eighths as broad as long, just twice or slightly less than twice as long as the prothorax; the lateral carina almost straight, at least in the basal half, and forming a distinct angle with the base, usually forming a right angle or nearly so, rarely slightly rounded; sculpture similar to but not so coarse as that of the pronotum. *Legs* less coarsely reticulate than the sternum. *Sternum* very coarsely reticulate throughout; the fore coxae separated by about half the breadth of a coxa by a prominent intercoxal process, the mesocoxae not quite so broadly separated, the metacoxae more broadly separated than the fore coxae. *Venter* coarsely reticulate, sometimes less coarsely so than the sternum; the first ventrite single in the female but with a distinct crater-like, median fovea in the male. Length, 1.25-1.50 mm.; breadth, 0.5-0.6 mm.

Rapa: holotype male and 22 paratypes beaten from shrubs on the northeast ridge of Mangaoa Peak, elevation 900-1,200 feet, July 4, 1934; 12 paratypes same locality, elevation 1,000-1,200 feet, July 25; allotype female and three paratypes beaten from *Metrosideros,* same locality and elevation, July 6; 14 paratypes collected at Maitua, elevation 700-800 feet, July 2, four beaten from dead branches of *Homolanthus,* 10 beaten from dead branches; 14 paratypes collected on the east ridge of Mount Perahu, elevation 1,200-1,500 feet, July 21, one beaten from *Fitchia,* seven from *Lautea,* and six from *Coprosma*; three paratypes from Karopo Rahi Islet, elevation 100-300 feet, July 18. The 73 specimens were collected by me.

This tiny species is allied to *Cis tahitiensis* and *Cis montevagus*. Its smaller and less robust prothorax will distinguish it from *Cis tahitiensis*. From *Cis montevagus* it may be distinguished by its duller, more coarsely reticulate derm, more conspicuous setae, more laterally rounded prothorax, and less distinctly upturned anterior cephalic margin.

9. **Cis adamsoni** Blair: B. P. Bishop Mus., Bull. **98**:242, fig. 54, 1932.

Female. Derm black, dull, with the antennae and tarsi pale; dorsal setae white, minute and inconspicuous.

Head with the crown and front broadly exposed in the single specimen at hand; but slightly convex in longitudinal dorsal outline from the top to the clypeus; the anterior margin rather evenly and broadly upturned, the clypeus subtruncate in front; very coarsely reticulate throughout, indistinctly punctate and setose. *Antennae* with the first segment three fourths as broad as long, about one fourth longer than two, two about one third longer than broad, fully as long as three plus half of four, four somewhat broader and shorter than three, five to seven successively slightly shorter, eight and nine apically subtruncate, eight only about half as large as nine, ten about as broad as long and about as long as

eight plus nine. *Prothorax* slightly transverse (1.7:1.5), the sides broadly arcuate; the lateral margin not visible from above, its basal angle distinct, obtuse, but rounded, thence almost straight to the anterior margin where the angle is distinct and of about 135°; dorsum very coarsely reticulate throughout, minutely and indistinctly punctate. *Elytra* broadly rounded on the sides but subparallel-sided in the basal half, two thirds as broad as long, almost twice as long as the prothorax; sculpture rather similar to that of the pronotum; the lateral carina rounded at its junction with the base. *Sternum* coarsely reticulate throughout. Length, 1.1 mm.; breadth, 0.5 mm.

Marquesas: Eiao. The female holotype in Bishop Museum and a female paratype in the British Museum are the only known specimens of this species.

This small species somewhat resembles *Cis arbustensis* but has the lateral carina of the elytra quite rounded into the basal carina, a differently shaped prothorax, much less conspicuous dorsal setae and distinctly produced and upturned anterior cephalic margin.

10. Cis cheesmanae Blair: Ann. Mag. Nat. Hist. IX, **20**:167, 1927.

Derm shiny reddish brown to castaneous to black throughout; dorsal setae microscopical and hardly discernible.

Head with crown and front either partially concealed by the pronotum or exposed; the crown very steep in the male, almost vertical and forming an angle of 90° with the teeth on the anterior margin; with a rather large, triangular, conspicuous, upturned tooth on either side of the clypeus, the apices of which form 90° angles in the male; smaller, less conspicuous and obtusely rounded off in the female; minutely punctate. *Antennae* with the first segment subglobose, almost as broad as long, longer and more convex on the outer than inner sides, as long as segment three plus four, two lost in dissection, three about as long as four plus five, four as long as five plus half of six, five, six and seven successively shorter and more transverse, eight and nine slightly transverse and subequal in size and shape, ten almost as long as eight plus nine, acutely pointed in the distal half. *Prothorax* transverse (1.4:1), slightly arcuate on the sides, broadly rounded at the apex; the lateral carina visible throughout its length from above, its basal angle well rounded, thence distinctly arcuate to the apical margin where the angle is distinct; the distal margin single in both sexes and making an angle of about 135° with the horizontal axis; dorsum finely or inconspicuously alutaceous and minutely punctate throughout. *Elytra* almost three fourths as broad as long, slightly more than twice as long as the prothorax, arcuate on the sides from the base to apex; punctures small, shallow and close, but larger than those on the pronotum. *Sternum* distinctly, densely and more conspicuously and somewhat more coarsely punctate than the dorsum; the fore coxae separated by about one third the breadth of a coxa, but slightly more widely separated than the mesocoxae. *Venter* with the first ventrite more distinctly punctate than the others, simple in the female but armed with a prominent, subconical, setigerous, median tubercle in the male. Length, 1.5 mm.; breadth, 0.75 mm.

Marquesas: Hivaoa. Society Islands: Tahiti.

The shiny, reddish individuals of this species might be confused with females of *Cis furicollis*, but it is distinctly ovate in shape, whereas *Cis furicollis* is parallel-sided. The anterior margin of the prothorax in *Cis cheesmanae* is less produced and the lateral angle is distinct. The two species are not closely allied. *Cis cheesmanae* is, however, closely allied to *Cis marquesanus*. From that species it may be distinguished by its ovate instead of subparallel-sided, subcylindrical body and by its dorsal setae which are hardly discernible.

In addition to a pair of red specimens from the Marquesas compared with the type by Dr. Blair, I have a black specimen from Tahiti, beaten by me from a shrub on Mount Aorai Trail, elevation 4,500-5,500 feet, September 14, 1934. I can find no differences on this specimen besides color to separate it from the typical red form and I believe that larger series will show that the species is dicromatic or that it varies from red to black.

11. Cis marquesanus Blair: Ann. Mag. Nat. Hist. IX, **20**:168, 1927 (fig. 1, *k*).

Derm variable, chestnut brown to black, rather shiny, appendages paler; dorsal setae white, very fine, short but hairlike, prostrate or slightly inclined.

Head with the crown and frons either concealed by the pronotum or quite freely exposed; finely reticulate, punctate and setose; the anterior margin upturned in both sexes, slightly so in the female, but with a variable triangular or somewhat rounded tooth on either side of the clypeus in the male. *Antennae* with the first segment asymmetrical, longer on the outer side, oblique at the apex, one fourth longer than broad, one fourth longer than the second, two rather evenly ovate in shape, slightly longer than broad, as long as three, three half as broad at two, almost as long as four plus five, four about as long as five plus six, five to seven successively slightly broader, eight and nine subequal, each about one quarter broader than long and slightly convex distally, ten ovoid, acutely pointed, as long as eight plus nine. *Prothorax* slightly transverse (2.2:1.9), arcuate on the sides; the lateral carina visible from above for at least its basal half, its basal angle well rounded, thence arcuate to the fore margin where the angle is rounded; finely to rather coarsely reticulate, minutely and densely punctate throughout. *Elytra* subparallel-sided in the basal two thirds, five eighths as broad as long, distinctly more than twice as long as the prothorax; basal angle of the lateral carina broadly rounded; densely, shallowly, minutely, subconfluently punctate throughout. *Sternum* alutaceous to rather coarsely reticulate, minutely punctate; fore coxae separated by about half the breadth of a coxa, mesocoxae not more than half as broadly separated as the fore coxae. *Venter* with the first ventrite simple in the female but with an inconspicuous, setose, median fovea in the male. Length, 1.1-1.5 mm.; breadth, 0.5-0.6 mm.

Society Islands, Rapa, Tuamotu Archipelago, Mangareva and Marquesas Islands. Holotype in the British Museum.

Heretofore this species has been recorded from Hivaoa in the Marquesas and Tahiti in the Society Islands. The following data are new:

Society Islands: Moorea, 55 specimens taken by me from dead shelf fungi at Tehau Point, elevation 10 feet, September 24, 1934.

Tuamotu Archipelago: Makatea, three specimens taken from dead shelf fungi by the late G. P. Wilder, September 1932.

Rapa: 103 specimens taken by me from dead shelf fungi growing on a stump on the west slope of Mount Taga, elevation 700 feet, July 26, 1934.

Mangareva Islands: Mangareva, nine specimens taken by me from beneath the bark of a dead log of *Mangifera indica* near the convent, elevation 300 feet, May 24, 1934.

This widespread species varies in size, color, development of the anterolateral cephalic teeth and other characters. The head may be deflexed and the crown and front freely exposed, or these parts may be concealed to between the eyes by the pronotum. Hence, the use of this character to separate species, as used by Blair in his key, cannot be upheld. In those eight specimens which I have dissected, the wings are fully developed for flight.

This species could perhaps be confused with females of *Cis furicollis,* but its more slender form and longer dorsal setae will distinguish it. From *Cis cheesmanae* it may also be separated by its more slender, subparallel-sided form and more conspicuous dorsal setae.

11a. Cis marquesanus merytae, new subspecies (fig. 1, *g*).

Male. Derm black, not distinctly shiny, head, thorax, apex of the elytra and abdomen somewhat diluted with red, the appendages reddish brown; dorsal setae conspicuous, rather dense, short and apparently white but with slight iridescent reflections.

Head with the crown and front concealed by the pronotum which reaches to a point above the anterior edge of the eyes in the single male at hand; reticulate but not distinctly punctate; the anterior margin with a rather large, conspicuous, triangular, slightly upturned tooth on either side of the clypeus, the apex of each tooth equals a 90° angle. *Antennae* with the first segment, excluding the segment-like pedicel, robust, much more convex on the outer side than on the almost straight inner side, two fifths longer and about one third broader than two, two about as long as three and about twice as broad, three fully as long as four plus five, four as long as five plus half of six, five to seven each successively slightly shorter and more transverse, eight and nine subequal in size and shape, or eight very slightly smaller, ten somewhat broader than nine, as long as nine plus half of eight, acutely pointed in the distal half. *Prothorax* transverse (1.4:1.1), broadly arcuate on the sides and apex; the lateral carina visible for most of its length from above, the basal angle rather abruptly rounded, thence but slightly

arcuate to the anterior margin, the anterior angle distinct but well rounded off at the corner, the anterior margin simple, forming an angle of about 35° with the vertical axis; finely reticulate throughout and not obviously punctate. *Elytra* slightly arcuate on the sides in the basal half, thence more rapidly rounded to the apex, about three fifths as broad as long, slightly less than two and one half times as long as the prothorax; finely reticulate and microscopically punctate, but appearing impunctate. *Sternum* with the fore coxae separated for a distance about equal to half the breadth of a coxa, the intercoxal process of the mesosternum not so broad as that of the prosternum; pro- and metasterna coarsely reticulate, minutely and inconspicuously punctate, sparsely and finely setose. *Venter* coarsely reticulate, indistinctly punctate; the first ventrite with a conspicuous median tubercle midway between the base and apex. Length, 1.75 mm.; breadth, 0.75 mm.

Rapa: holotype male collected by me from under bark of *puru* (*Meryta*) on the north slope of Mount Tautautu, elevation 700-800 feet, July 8, 1934.

I had at first considered this form to be a distinct species. Upon preliminary examination it appeared quite distinct from *Cis marquesanus*, but detailed comparisons show few characters to separate it as a species. A series of both sexes would give additional data upon which to base a more concrete definition. This insect is somewhat broader and not quite so parallel-sided as true *Cis marquesanus*; the entire dorsum is so densely, although minutely, reticulate that a mat surface is produced, whereas on *Cis marquesanus* the surface, although finely alutaceous or reticulate, is quite shiny. For these reasons I believe this form should be named as a subspecies.

Genus POLYNESICIS, new genus

Antennae 9-segmented, the first and second segments submoniliform, the first larger than the second, three slender and but slightly longer than four, five to seven successively shorter, seven to nine forming a loose club which is almost as long as the preceding part of the antennae, the segments successively larger. *Mandibles* toothed. *Legs* with the femora grooved for the reception of the tibiae; tibiae simple, not abnormally expanded nor serrate; tarsi with the second and third segments very small, the fourth about twice as long as the preceding three segments. *Venter* with the first ventrite slightly longer than two plus three, two to four subequal, five somewhat longer than four. *Elytra* slightly fused; wings entirely absent.

Genotype: *Polynesicis hirsutus,* new species.

This genus is closely allied to *Cis* in general structure and form,

but the antennae have nine segments, the elytra are fused and the wings are absent (the wings are occasionally atrophied in *Cis*, however). In addition to these differences there are evidently no other conspicuous characters to separate *Polynesicis* from *Cis*. *Polynesicis* differs from the Hawaiian *Apterocis* by not having the body strongly longitudinally convex dorsally and by its 9- instead of 10-segmented antennae. It differs from *Enncarthon*, which also has 9-segmented antennae, by not having the fore tibiae thickened.

Polynesicis hirsutus, new species (fig. 1, *e, j*).

Derm black, shiny above, with the appendages reddish brown; dorsal setae very conspicuous, long, erect and hairlike, that on the elytra about one third as long as the breadth of an elytron, dark but with bronzy reflections.

Head with the crown and front normally mostly concealed by the pronotum, but occasionally bent downward and exposed; coarsely reticulate, distinctly punctate; the anterior margin but slightly upturned in both sexes, even and without teeth. *Antennae* with the first segment ovate, one fourth longer than broad, one third broader and one fourth longer than two which is as long as three but twice as broad, three as long as four plus half of five, four slightly longer than five which is slightly longer than six, seven rather evenly rounded or somewhat transverse, almost as long as five plus six, slightly or about one fourth shorter and narrower than eight, nine about as long or slightly longer than eight plus half of seven, elongate oval, but acutely pointed at the apex. *Prothorax* slightly transverse (2.5:2.3); the lateral margin visible for most of its length from above, its basal angle rounded, thence but slightly arcuate to the apex and making an angle of about 135° with the apical margin; finely alutaceous, conspicuously, densely, and rather coarsely punctate, the punctures somewhat variable, but usually rather coarse, with their interstices not broader than their diameters, each puncture giving rise to a long hair similar to those on the elytra. *Elytra* arcuate on the sides from base to apex; five sevenths as broad as long, one and three fourths times as long as the prothorax; the sculpture similar to that on the pronotum, but with the punctures shallower and individually less distinct. *Legs* with the femora broad and compressed; tibiae slender, somewhat shorter than the femora, finely hirsute. *Sternum* coarsely reticulate throughout, sparsely and inconspicuously hirsute; intercoxal process of the prosternum almost half as broad as a coxa; mesocoxal cavities coalescent, metacoxae separated by a triangular process. *Venter* coarsely reticulate, sparsely hirsute; the first ventrite simple in the female, but with a slightly raised but craterlike, oval, more densely pilose median process in the male. Length, 1.0-1.6 mm.; breadth, 0.45-0.75 mm.

Rapa. Holotype male, allotype female, and 38 specimens collected by me as follows: holotype, allotype, 14 paratypes, two dissected specimens, and two broken specimens beaten from dead branches in the southeast valley of Mount Ororangi, elevation 600-700 feet, July 1934, six paratypes with the same data, but three beaten from *Piper* and three beaten from ferns; five specimens from the south slope of Mount Tepiahu, elevation 400-600 feet, July 20, two paratypes beaten

from ferns, two paratypes and a broken specimen dug from beneath dead bark of *puru* (*Meryta*) ; six paratypes beaten from dead branches at Maitua, elevation 700-800 feet, July 2; two paratypes with the same data but beaten from *Homolanthus*; one paratype beaten from a shrub on the northeast ridge of Mangaoa Peak, elevation 1,000-1,200 feet, July 25.

Austral Islands: Rurutu, one specimen collected by me from the southwest slope of Mount Manureva, elevation 1,000 feet, August 25, 1934, agrees in most characters with the holotype. However, it is somewhat less coarsely and densely punctate and may possibly represent a subspecies. A larger series is necessary to ascertain its true status.

Upon dissection it was found that the elytra of this species were slightly fused. No trace of wings could be found in cleared, balsam mounts of dissections.

Among the *Ciidae* described herein, this hairy species most closely resembles *Cis uapouae* but is shorter and more robust and has 9- instead of 10-segmented antennae.

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV | December 15, 1938 | Number 13

Anthribidae of Southeastern Polynesia[1] (Coleoptera)

By ELWOOD C. ZIMMERMAN

INTRODUCTION

Scope

This paper is founded on the collections made by me while on the Mangarevan Expedition to southeastern Polynesia in 1934. It treats of all the Anthribidae known from the islands south of Hawaii and east of the 160th meridian, or, roughly, east of Samoa. Twelve genera and fourteen species are included; of these, three genera and four species are described as new. The collection studied includes 532 specimens, 521 of which were procured by the Mangarevan Expedition, and 11 of which were from the general collection of Bernice P. Bishop Museum. Much new data on geographical distribution are recorded, and the ranges of most of the described species have been found to be greater than has heretofore been known. The types of the new species and the collection are stored in Bishop Museum.

I wish to express my sincere thanks to Dr. Karl Jordan of the Zoological Museum at Tring for his unfailing kindness and aid to me during the preparation of this paper. Without his help, it would be quite impossible for me to present this work as it now appears.

Previous Work

The first paper reporting Anthribidae from southeastern Polynesia was that of Leon Fairmaire in Revue et Magazin de Zoologie for 1849. He described two new genera and three new species collected by Vesco on Tahiti. In 1866 Lacordaire considered Fairmaire's

[1] Rhynchophora of southeastern Polynesia publication 10.
[2] Mangarevan Expedition publication 28.

genera and species in volume 7 of his "Genera des Coléoptères" and placed his two genera, *Dinema* and *Rhinobrachys,* among the "genres incertae sedis." In the following 58 years nothing was written on the Anthribidae of southeastern Polynesia. In 1924, Dr. Karl Jordan redescribed *Dinema* Fairmaire (Novitates Zoologicae, vol. 31). In 1933, Dr. Jordan wrote his "Anthribidae from the Marquesas Islands" and "Anthribidae from the Society Islands" (B. P. Bishop Mus., Bulls. 114 and 113). In these two papers seven species were recorded, including one new genus, three new species, and a new subspecies.

Analysis of the Fauna

The eastern Pacific islands have a poorly developed anthribid fauna. The paucity of species is surprising, considering the great tracts of tropical forest on the many islands of the region. Little endemicity is shown among the species described here. Of the 14 species recorded from the region, eight are widespread, five are probably endemic, and one is doubtfully endemic. The following table will show the comparative developments of the known anthribid faunas of eastern Oceania:

	Fiji	Samoa	S. E. Polynesia	Hawaii
Number of genera	7	9	12	4
Number of species	9	14	14	6

This table does not indicate the true developments of the faunas, because it is based on described species only. In the collections before me there are enough new species from Fiji to indicate that the anthribid fauna of that region is much more complex than in any other eastern oceanic island group. It is probable, I believe, that the anthribid fauna of Fiji is larger than the corresponding faunas of all the islands to the east combined. In numbers and complexity, it is rivaled only by the Samoan fauna. Some endemic genera and several endemic species have been described from Samoa. With the exception of a few native *Araecerus,* no endemic Anthribidae are found in the Hawaiian islands.

With the possible exception of the monotypic genus *Cisanthribus,* the Anthribidae of southeastern Polynesia are Indo-Pacific in origin and affinities. *Cisanthribus* is, according to Dr. Karl Jordan, allied to a Central American genus. When more thorough collecting is done in the western Pacific, however, it may be found that genera more closely allied to *Cisanthribus* occur there. Of the remaining 11 genera, three are evidently endemic and eight are widespread in the

Pacific. Of these eight genera, three are Oceanic, three are Indo-Pacific in distribution, one continues westward through the Old World tropics to the Ethiopean region, and one is tropicopolitan.

Such species as *Neseonos brunneus, Proscopus veitchi,* and species of *Araecerus* are admirably suited to artificial distribution by man from island to island. *Proscopus veitchi,* for example, inhabits dead coconut fronds and dead banana leaves and is readily attracted to coconut-frond baskets packed with dried banana leaves to protect food and other supplies for over-sea journeys. *Araecerus* are easily carried from place to place among seeds or dried plant materials. Most other anthribids of southeastern Polynesia are also suited to such agencies of distribution.

The two species of *Araecerus* are the only anthribids of the region which may cause damage and are of any economic importance, as far as I know. These two anthribids attack the seeds or pods of coffee, nutmeg, cotton, cocoa, *Hibiscus tiliaceus*, and other plants. *Araecerus fasciculatus* is a noted coffee pest, but it is not common in southeastern Polynesia.

Check List

1. **Phloeobius gigas horeus** Jordan.
   Marquesas, Society, and Hawaiian islands.
2. **Aethessa mumfordi** Jordan.
   Marquesas.
3. **Aethessa adamsoni** Jordan.
   Marquesas.
4. **Notioxenus cylindricus** Jordan.
   Society and Austral Islands, and Henderson Island.
5. **Neseonos brunneus,** new genus, new species.
   Henderson, Mangareva, Pitcairn, Rapa, and Fiji.
6. **Dinema filicornis** Fairmaire.
   Tahiti.
7. **Proscopus veitchi** Jordan.
   Mangareva, Rapa, Austral, Society, Flint, Samoa, and Fiji islands.
8. **Jordanthribus planifacietus,** new genus, new species.
   Mangareva, Austral, Society, and Marianas Islands.
9. **Mauia subnotatus** (Boheman).
   Indo-Pacific.
10. **Araecerus fasciculatus** (De Geer).
    Almost cosmopolitan.
11. **Araecerus vieillardi** (Montrouzier).
    Oceania.
12. **Melanopsacus rapaae,** new species.
    Rapa.
13. **Cisanthribus convexus,** new genus, new species.
    Society Islands.
14. **Rhinobrachys asperulus** Fairmaire (status uncertain).
    Tahiti.

Some of the characters that I have used in the generic descriptions and key may possibly not hold good for other faunas but are here used for convenience in separating the genera found in southeastern Polynesia. The measurements of the length of the species exclude the head.

Key to the Genera

1. Dorsal pronotal carina antebasal 2
   Dorsal pronotal carina basal, that is contiguous with the basal margin of the elytra 9

2(1). Antennae inserted on the rostrum usually at or nearly at the sides, rarely on the front of the rostrum 3
   Antennae inserted on the head, either on the inner sides of the eyes near their tops or at the lower margin of the eyes; with a distinct tuberculiform callosity above the scrobe 6

3(2). Eyes very distinctly emarginate on the lower margin above the insertion of the antennae; length 7-10 mm .... **Phloeobius**, p. 223
   Eyes entire, not at all emarginate; length 1.4-4 mm 4

4(3). Antennae inserted on the front of the rostrum, second segment less than half as long as the third; interscrobal area less than half as broad as the interocular area .... **Aethessa**, p. 225
   Antennae inserted on the sides of the rostrum below the eyes, second segment longer than third; interscrobal area at least three fourths as broad as the interocular area 5

5(4). Prothorax with a conspicuous lateral carina extending from the base to slightly past the middle on the sides; length 2.5-3.5 mm. .... **Mauia**, p. 239
   Prothorax without a carina at the sides; length less than 2 mm. .... **Notioxenus**, p. 228

6(2). Rostrum subcylindrical at the base, much longer than broad; eye reniform, the upper lobes approximate, the distance between them only about one fourth as broad as the narrowest part of the rostrum; lateral carina of the prothorax continued to the apex .... **Dinema**, p. 233
   Rostrum flattened, never subcylindrical at the base, as broad as long or longer than broad; eye not deeply notched, almost or quite entire, not approximate dorsally, interocular area at least fully half as broad as the narrowest part of the rostrum; lateral carina of the prothorax either continued to the apex or terminating behind the apex 7

7(6). Eyes transverse and almost horizontally placed on the head; antennae inserted at the lower margin of the eyes at about their middle but terminating at about one third from the apex .... **Neseonos**, p. 229
   Eyes longitudinal, vertically placed on the head, or but slightly oblique, never horizontal nor almost so; antennae inserted on the front at the dorsal margins of the eyes 8

8(7). Lateral prothoracic carina continued prominently to the apex; first antennal segment not more than half as long as two plus three .... **Proscopus**, p. 233

Lateral prothoracic carina reaching only to about the middle; first antennal segment approximately as long as two plus three..**Jordanthribus**, p. 236

9(1). Elongate or stout, subparallel-sided, densely pilose species; scutellum visible; elytra shallowly punctate-striate; metasternum distinctly longer between the mid and hind coxae than a metacoxa; 2-4 mm. long 10

Very small, strongly convex, shiny black species; bare or sparsely pilose above; elytra (in the known species of this fauna) confusedly punctate, not striate; metasternum between the mid and hind coxae much narrower than a metacoxa; not or but slightly more than 1½ mm. long.. 11

10(9). Mandibles toothed; second antennal segment distinctly shorter than the third; interscrobal area distinctly narrower than the interocular area; lateral prothoracic carina not passing the middle. ....**Araecerus**, p. 241

Mandibles not toothed; second antennal segment fully as long or slightly longer than the third; interscrobal area as broad or broader than the interocular area; lateral prothoracic carina distinctly passing the middle..**Mauia**,[3] p. 239

11(9). Lateral prothoracic carina not or hardly reaching the middle; hind coxae transverse, reaching the metepisterna....**Melanopsacus**, p. 245

Lateral prothoracic carina continuous and sharply defined from base to apex; hind coxae glabular, similar in shape with the mid coxae..**Cisanthribus**, p. 247

Genus PHLOEOBIUS Schönherr, 1826

Head and rostrum continuously convex; eyes very large, horizontally placed, strongly protuberant laterally beyond the sides of the head, reniform, the lower margins conspicuously emarginate at the middle, almost twice as broad as the narrowest part of the interocular area; interocular area sub-V-shaped, less than half as broad at the apex as at the base. *Rostrum*, excluding the mandibles, much shorter than the head, about half as long from the apex of the eyes to the apex of the labrum as the breadth between the subscrobal tubercles; apical margin rather deeply and roundly emarginate behind the labrum which is convex and strongly rounded distally; mandibles slightly sinuous internally and not toothed; antennae inserted on the sides at the base, the dorsal margin of the scrobe contiguous with the lateral lobe of the eye, the subscrobal tubercles large and conspicuous. *Antennae* extending only to the base of the elytra in the female, but slightly longer than the body in the male; segments as follows in the male: the first segment large, subconical, as broad at the base as long, as long as two, three somewhat less than four times as long as two and as long as four plus half of five, four slightly longer than five to eight inclusive, five to eight subequal in length, nine about four fifths as long as eight and about one fourth longer than ten, nine and ten somewhat flattened, eleven about as long as eight plus nine, styliform, slightly sinuous; segments as follows in the female: the first and second as in the male, third and fourth subequal in length, each twice as long as the second, four not quite as long as five plus six, five slightly longer than six, six and seven subequal in length, eight as long as seven plus half of six, somewhat flattened and distinctly broader than seven, not quite as long as nine and only half as broad, nine to eleven forming a distinct, flattened,

[3] *Mauia* is placed in two parts of the key, because the prothorax is often bent downward in dead specimens, making the dorsal carina appear somewhat antebasal rather than basal.

asymmetrical club, the dorsal margin almost straight, the ventral margin serrate, nine about as broad as long at the apex, slightly longer than ten which is as broad as long, eleven slightly longer than nine and only about three fourths as broad. *Prothorax* convex, broader than long, dorsal carina antebasal, lateral carina forming an almost right angle with the basal carina and terminating slightly beyond the middle. *Scutellum* visible. *Elytra* subparellel-sided, slightly more than twice as long as the prothorax, serially punctate. *Legs* with the femora strongly clavate, edentate; tibiae rather slender; first tarsal segment slightly longer than the second, third half as long as the second and deeply immersed in the second, giving the tarsi a 3-segmented appearance, fourth segment as long as the first, claws with a slender tooth before the middle. *Sternum* with all the coxae separated, the hind coxae narrowly separated by the triangular intercoxal process, transverse and extending from close to the median line almost to the elytra. *Body* densely pilose above and below; marmorated with paler and darker patches above.

This genus has a wide distribution continuing westward from Polynesia through Australia, Papua, Java, Sumatra, southern China, India to Africa and Madagascar.

1. **Phloeobius gigas horeus** Jordan: B. P. Bishop Mus., Bull. **114**: 33, 1933; (fig. 1, *m*).

This large subspecies (7-10 mm.) is the largest and most easily recognized of all of the Anthribidae of southeastern Polynesia. I have included specific characters in the generic description, and no difficulty should be encountered in identifying this subspecies.

Phloeobius gigas gigas Fabricius, 1775, is distributed through the Malayan and Papuan regions, and subspecies have been described from the Oriental region and Malagasy subregion. *Phloeobius gigas horeus* is very closely allied to *Phloeobius gigas cervinus* Klug, 1838, from the Malagasy region.

Marquesas Islands:

Tahuata (type locality) and Hivaoa. It probably inhabits most of the islands of the group.

Hawaiian islands:

Oahu; first collected in Honolulu in 1924.

Society Islands:

Tahiti, nine specimens collected by me at light near the seashore at Blue Lagoon, near Papeete, March 1, 1934, and one specimen taken by me off a partially dead *Inocarpus edulis* tree at Tiupi Bay, Papeari.

Raiatea, two specimens collected by J. W. Moore, 1926-1927.

This anthribid will undoubtedly be found on many islands of eastern Polynesia. Heretofore, it has been recorded only from the Marquesas and Hawaii.

Genus **AETHESSA** Jordan, 1933

Head and rostrum rather continuously convex; eyes strongly convex, almost round, but slightly longer than broad, longitudinally placed on the head, half as broad as the interocular area. *Rostrum* not quite as long as the head, distinctly broader than the length between the apex of the eye and the apex of the labrum; antennae inserted inside the inner lower edge of the eyes on the front of the rostrum, not at its sides, the shortest interscrobal breadth only half as broad as the interocular area, with a well-developed, rounded tubercle at the lower edge of the scrobe, the distance between the tubercle and the apex of the rostrum about as long as the breadth of the first antennal segment, the dorsal margin of the scrobe reaching the eye; mandibles with at least a subapical tooth. *Antennae* reaching or passing the middle of the elytra in the male, the segments in the male as follows: the first segment half as broad as long, not passing the lateral margin of the eye, one and one half to twice as long as the second, which is about one third as long as the third, three longer than four to eight inclusive, which are subequal in length, nine to eleven flattened, forming a loose, rather symmetrical club, nine as long as eight and distinctly longer than ten, ten subtriangular, eleven ovate. *Prothorax* broader than long; dorsal carina antebasal, but subbasal at the middle, lateral carina short, not reaching the middle, lateral longitudinal carinula oblique, forming inwardly an obtuse angle with the dorsal carina and outwardly an acute angle with the lateral carina. *Scutellum* minute, but visible. *Elytra* subparallel-sided, about three times as long as the prothorax, base broadly and shallowly emarginate from the humeri to the suture; shallowly punctate-striate. *Legs* rather long and slender, femora not very strongly clavate, edentate; tibiae very slender, at most armed with a row of slender terminal spines; tarsi with the fourth segment free and distinct, not immersed in the second; claws bifid at the apex or with a small tooth near the apex. *Sternum* with the coxae narrowly separated, the fore coxae subcontiguous, the hind coxae very narrowly separated by the triangular intercoxal process, transverse and almost extending to the elytra. *Body* densely pilose above and below.

The mandibles on the types are so tightly closed that it is impossible to ascertain whether there are more teeth on the mandibles than the subapical one here recorded.

This genus was erected by Jordan for the reception of two Marquesan species of which only the unique male types, in Bishop Museum, are known. The genus has thus far been found only in the Marquesas, and I collected no specimens on the numerous islands I visited in southeastern Polynesia.

The species of this genus somewhat resemble elongate *Araecerus* or *Mauia* in the southeastern Polynesian fauna, but are not at all closely related to those genera. Jordan has placed this genus near *Misthosimella* Jordan, 1914, and *Misthosima* Pascoe, 1859. *Misthosima* is Indo-Australian, whereas *Misthosimella* is Ethiopian.

KEY TO THE SPECIES

Each elytron with a broad prominent, conspicuous callosity near the base, extending over intervals two, three, and four; dorsal outline of the head and rostrum distinctly convex from the base of the head to the subscrobal tubercle; first fore tarsal segment slightly more than half as long as a fore tibia; antennae of the male reaching the fourth ventrite .... **A. mumfordi.**

Elytra without prominent subbasal callosities; dorsal outline of the head and rostrum conspicuously flat and continuous from the top of the head to the subscrobal tubercle; first fore tarsal segment slightly less than half as long as a fore tibia; antennae of the male reaching only to the hind margin of the first ventrite .... **A. adamsoni.**

2. **Aethessa mumfordi** Jordan: B. P. Bishop Mus., Bull. **114**:35, fig. 1, 1933.

This species, the genotype, has the derm of the elytra mottled here and there with dark brown areas, making them distinctly darker than those of *A. adamsoni*; the pronotum is shallowly but conspicuously, longitudinally impressed on either side of the median line. These characters together with the longer antennae, convex head, and the prominent subbasal callosities on the elytra will readily separate this species from *A. adamsoni*. Length, 3.5 mm.; breadth, 1.4 mm.

Marquesas: Nukuhiva.

3. **Aethessa adamsoni** Jordan: B. P. Bishop Mus., Bull. **114**:36, fig. 2, 1933; (fig. 1, *a*).

This species evidently lacks the conspicuous dark elytral, dermal markings as found on *A. mumfordi* and the color is paler; the pronotum is rather evenly convex and not conspicuously impressed longitudinally. Jordan was in error when he described the antennae as not reaching to the middle of the elytra. The type was poorly mounted with one antenna broken off and the other bent beneath the body and entwined among the legs when it was described. I have remounted it and straightened the antennae and find that they reach to the hind margin of the first ventrite, or to slightly beyond the middle of the elytra. Length, 3.3 mm.; breadth, 1.4 mm.

Marquesas: Hatutu.

The elevations at which the holotypes of the two species were collected were omitted from the original descriptions. They are as follows: for *A. mumfordi,* 3,485 feet; for *A. adamsoni,* 1,080 feet.

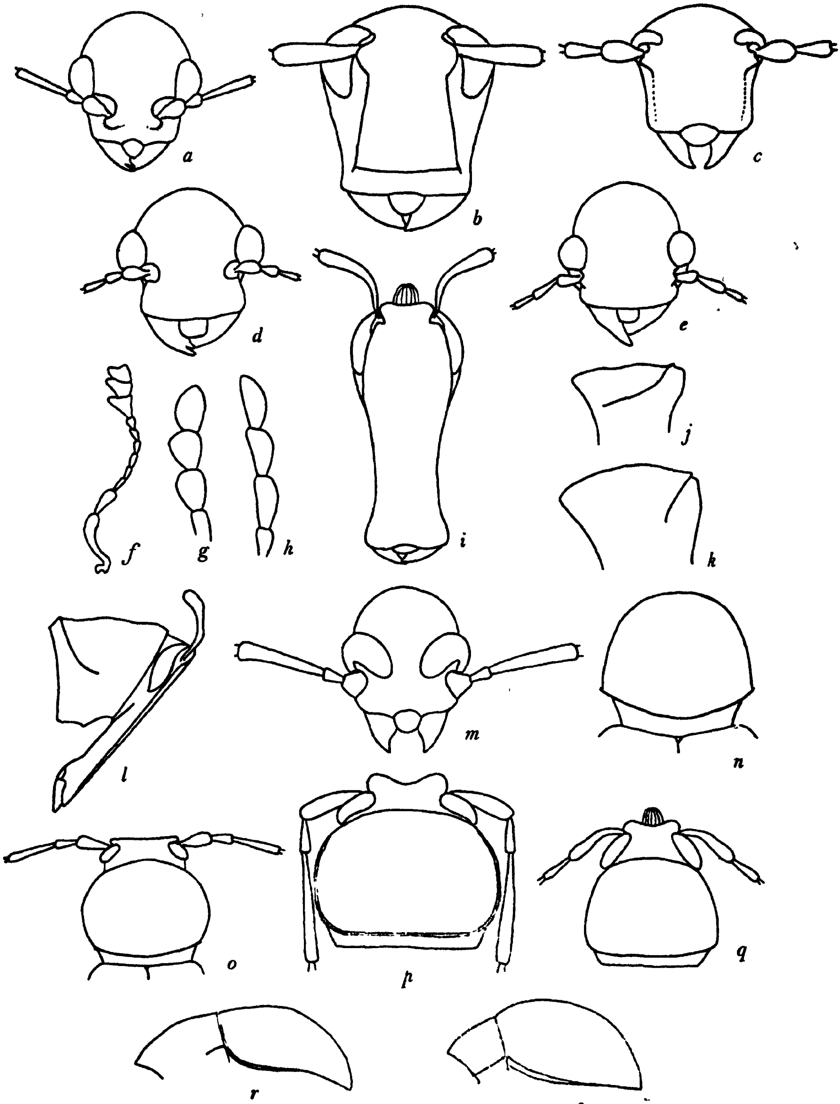

FIGURE 1.—*a, Aethessa adamsoni*; *b, Proscopus veitchi*, male; *c, Neseonos brunneus*, female; *d, Araecerus vieillardi*; *e, Mauia subnotatus*; *f*, antenna of *Cisanthribus convexus*; *g* and *h*, antennal clubs of *Araecerus vieillardi* (*g*) and *A. fasciculatus* (*h*); *i, Jordanthribus planifacietus*, male; *j*, side view of prothorax of *Neseonos brunneus*; *k*, side view of prothorax of *Notioxenus cylindricus*; *l*, side view of head and prothorax of *Jordanthribus planifacietus*, male; *m, Phloeobius gigas horeus*, male; *n*, dorsal view of prothorax of *Notioxenus cylindricus*; *o, Neseonos brunneus*; *p, Proscopus veitchi*; *q, Jordanthribus planifacietus*; *r, Melanopsacus rapaae*; *s, Cisanthribus convexus*.

Genus NOTIOXENUS Wollaston, 1861

Head convex; eyes lateral, strongly convex, circular, entire, more than half as broad as the interocular area. *Rostrum* from the lower margins of the eyes to the base of the labrum somewhat shorter than the head, almost twice as broad as long; mandibles toothed; antennae inserted at the sides of the rostrum at the lower inner margin of the eyes, the scrobe contiguous with the lower margin of the eye; interscrobal area very slightly nárrower or approximately the same breadth as the interocular area. *Antennae* reaching to or but slightly behind the bàse of the elytra; the segments as follows: segments one and two stout, subequal, or one longer than two, two longer and about twice as broad as three, three to eight successively slightly shorter and less slender, nine, ten, and eleven subequal in length, but with nine slightly longer, forming a loose, symmetrical club, the emarginations between the segments broad and subequal on either side, nine and ten subconical, eleven oval. *Prothorax* slightly transverse; dorsal carina antebasal, strongly arcuate, terminating on the sides above the fore coxae, without lateral carina or baso-lateral carinulae. *Scutellum* minute, but visible. *Elytra* twice as long as the prothorax (in our species). *Legs* with the femora not strongly clavate; tibiae shorter than the femora; second tarsal segment shorter than the next two together, the third segment broader than the second, not deeply immersed in the second, claws each with a long tooth, first fore tarsal segment about one fourth as long as the fore tibia. *Sternum* with all the coxae well separated, the fore pair by a distance equal to more than half the breadth of a fore coxa, hind coxae transverse, almost reaching the elytra; metasternum between the mid and hind coxae as broad as a hind coxa.

There is but one known species representing this genus in Polynesia. The genus was originally described from St. Helena, where the majority of the species occur. It has, however, a discontinuous, predominantly tropicopolitan distribution. Its species have been described from Japan, Central America, and the West Indies besides St. Helena and southeastern Polynesia, and I have seen an undescribed Micronesian species. It is probable that the genus is well developed in western Oceania.

4. **Notioxenus cylindricus** Jordan: B. P. Bishop Mus., Bull. **113**: 67-68, fig. 1, *a-b,* 1933; (fig. 1, *k, n*).

This small species can easily be recognized by the characters given in the key and the generic description without a detailed specific diagnosis. The derm is yellowish to reddish brown, with a rather conspicuous, roughly triangular, darker area on each elytron, the base of which is at the lateral margin of the elytron and is there continuous over the central half or third of the elytron, but it rapidly narrows dorsally to reach the suture just behind the middle forming a narrow, postmedian fascia with the same mark on the opposite elytron; the elytra are conjointly dark at the apex. The dorsal vestiture consists

of slender, rather coarse, almost prostrate white or pale pile, often darker or less dense on the dark areas, rather scattered and not concealing the derm. The pronotum has small, dense, subconfluent or confluent, rather coarse punctures. The elytral striae are distinctly punctate and impressed throughout. Length, 1.25-1.5 mm.; breadth, 0.5-0.75 mm.

This species was described from Tahiti and has heretofore not been known from any other region. The following data, assembled by me in 1934 during the Mangarevan Expedition are new:

Society Islands:

Tahiti, one specimen taken from a pod of an undetermined legume in Fautaua Valley, March 7.

Moorea, two specimens taken from dead pandanus leaves in Maramu Valley, elevation 800 feet, Sept. 26.

Raiatea, eight specimens picked from dead pandanus leaves on Temehani Plateau, elevation 1,400-1,600 feet, Oct. 5.

Austral Islands:

Raivavae, two specimens swept from grasses and low herbage, one near Ahueivi, elevation 5 feet, Aug. 8; one near Anatonu, elevation 5 feet, Aug. 13.

Rurutu, one specimen beaten from *Dryopteris* fern on Mount Teape, elevation 1,000 feet, Sept. 2.

Henderson Island: 42 specimens picked off dead leaves of pandanus on the north side near the seashore, June 16; two specimens from the northwest side, elevation 100 feet, June 17; six specimens beaten from shrubs on the northwest side, elevation 100 feet, three on June 19, the others on June 21.

This species is one of the smallest anthribids of southeastern Polynesia. It is quite different from some of the convex, shiny black species of its genus. It may be expected to occur on pandanus near the coast on most of the islands in southeastern Polynesia. Because of its small size and obscure coloration it may easily be overlooked by the collector. The sexes are quite similar. There is, however, a character on the males that has not heretofore been recorded: the anterior, ventral apex of the fore trochanter is produced into a sharp, conspicuous tooth.

Genus **NESEONOS**, new genus

Head with the eyes convex, coarsely faceted, lateral, reniform, the lower margin distinctly concave, oblique but almost horizontally placed on the head,

almost twice as broad as long, somewhat more than half as broad as the interocular area; antennae inserted on the sides of the head at about the middle of the lower margin of the eye, the actual point of articulation not farther from the lower margin of the eye than the narrowest part of the eye; the dorsal part of the scrobe contiguous with the lower median concavity of the eye, the inner dorsal margin of the scrobe produced into a prominent, strongly developed tuberculiform callosity, the distance between the lateral margins of these callosities, when viewed from the front, distinctly greater than the interocular area, the lateral margins almost in line with the middle of the eye. *Rostrum* conspicuously flattened, continuously flattened or concave with the head from the top of the eyes to the labrum, subparallel-sided from below the eyes to the mandibles, about twice as broad as the distance from the base of the scrobal callosity to the base of the labrum; with a vague dorso-lateral carina from the scrobal callosity to the apex, the sides of the rostrum forming an angle with the dorsum; the mandibles sinuous on the inner edges but not toothed. *Antennae* reaching to or slightly beyond the apex of the elytra in the female, about twice as long as the body in the male; the segments as follows in the male: first segment about twice as long as broad, stouter and somewhat longer than two, three about as long as one plus two, segments three to six inclusive similar and each successively slightly longer, seven shorter than six, seven to nine each successively slightly shorter but similar in shape to segments three to six, segments ten and eleven subequal in length, together not longer than nine, not dilated, there being no distinct club; in the female segments three to seven inclusive are subequal in length, eight is shorter than seven, nine shorter than eight and slightly broadened distally, ten and eleven together longer than nine and forming with nine a vague club. *Prothorax* transverse, dorsal carina antebasal, lateral carina continuously curved with the dorsal carina and not forming a distinct angle with it, reaching past the middle of the side but not to the apex, without distinct baso-lateral carinulae. *Scutellum* visible. *Elytra* subparallel-sided, twice or more than twice as long as the prothorax, punctate-striate. *Legs* with the femora clavate, but not strongly so; tibiae slender, fore tibiae about as long as the fore femora; first tarsal segment about as long as two plus three, third segment broader than and about as long as the third and not immersed in it, each claw with a subbasal tooth. *Sternum* with the fore and mid coxae separated by somewhat less than half the breadth of a coxa, hind coxae separated by about the breadth of a metacoxa at the trochanter, transverse, almost reaching the elytra; metasternum between the mid and hind coxae distinctly longer than the breadth of a metacoxa. *Venter* with the first ventrite as long as two plus three which are subequal in length, four slightly shorter than three or five. *Body* rather sparsely clothed with short, coarse pubescence that does not completely conceal the derm.

Genotype: *Neseonos brunneus*, new species.

This genus is closely allied to *Proscopus* but can be distinguished as follows: On *Neseonos* the lateral pronotal carina does not extend to the apex, the eyes are almost horizontal, and the antennae are inserted below their middles, the interscrobal area is almost as broad as the greatest breadth of the rostrum, and the lateral facial carinae are vague. On *Proscopus* the lateral pronotal carina extends prominently to the apex, the eyes are almost vertical, the antennae are in-

serted very close to their inner dorsal apices, the interscrobal area is only about two thirds as broad as the greatest breadth of the rostrum, and the lateral facial carinae are sharply defined and strongly developed from the scrobal callosities to the apex.

5. Neseonos brunneus, new species (fig. 1, *c*, *j*, *o*).

Derm yellowish brown to dark reddish brown, the appendages paler than the dorsum; pubescence grayish or yellowish, not forming patterns.

Head with the frons and rostrum continuously concave when viewed from the side, usually with a small, irregular interocular prominence; densely, rather coarsely but shallowly and irregularly punctate; scrobal tubercle strongly developed, the distance between them approximately the same as the breadth of the rostrum at the base. *Rostrum*, excluding the mandibles, subquadrate when viewed from the front, rather sharply angulate at the sides, the lateral facial carina distinct from the scrobal tubercle to the apex but only slightly elevated, apex roundly emarginate behind the labrum; pubescence of the head and rostrum rather long and hairlike, comparatively fine, anteriorly inclined, longer than that on the elytra. *Antennae* with the first segment slightly more than twice as long as broad, subovoid excluding the basal peduncle, not quite twice as long as the second; the second subconical, one fourth narrower than the first, twice as long as broad, three as broad as one plus two. *Prothorax* one fifth broader than long, the sides and apex broadly and almost continuously rounded, dorsal carina separated from the scutellum for a distance equal to that of the apical diameter of the second antennal segment, continuously curved at the side with the lateral carina, which extends two thirds the distance from the dorsal carina to the apex of the side of the prothorax; the disk usually shallowly, transversally depressed just in front of the dorsal carina and at about the middle, densely and shallowly punctate. *Elytra* somewhat less than three fourths as broad as long (3:4.5), two and one fourth times as long as the prothorax; base shallowly and broadly emarginate from the sides to the suture; striae distinctly impressed throughout, the punctures conspicuous, contiguous or nearly so; pubescence of the elytra and pronotum variable in length, either very short and specklike or moderately long, that on the prothorax usually longer. *Legs* finely, rather densely pubescent; the first fore tarsal segment only about one fourth as long as a fore tibia. *Sternum* usually rather densely set with moderately coarse, rounded, well-impressed punctures, but the punctures variable, often but shallowly impressed on the metasternum; pubescence fine and rather dense throughout, often rather silky. *Venter* with the punctuation and vestiture similar to that of the metasternum; the fifth ventrite almost twice as long as the fourth in the female, approximately as long or but slightly longer than the fourth in the male. *Pygidium* convex, but slightly impressed down the middle, rather shallowly and irregularly punctate, pubescence similar or somewhat coarser than that of the venter, broadly rounded at the apex, one fourth broader than long in the male, about one fifth broader than long in the female. Length, 2.25-3.6 mm.; breadth, 1.0-1.5 mm.

Mangareva, Henderson, Pitcairn, Rapa, and Fiji. Holotype male beaten by me from dead coconut fronds on the northeast side of Taravai Island, Mangareva Islands, June 1, 1934; allotype female beaten by me from dead *fei* leaves on the south side of Mount

Mokoto, Mangareva Island, Mangareva Islands, elevation 1,000 feet, June 2, and 142 paratypes, all but one collected by me, as follows:
Mangareva Islands:

Mangareva, 42 specimens with the same data as the allotype, five beaten from dead branches and leaves and two beaten from dead banana leaves, June 4; one specimen from the same locality and elevation, June 6; 19 specimens beaten from dead banana leaves at the same locality and elevation, June 7.

Agakauitai, 23 specimens collected June 8, elevation 10 feet, one from dead pandanus leaves and 22 beaten from dead banana leaves and dead coconut fronds.

Taravai, 30 specimens beaten from dead coconut fronds on the northeast side and two specimens swept from grasses and low herbage near Taravai village, June 1.

Henderson Island: one specimen from dead pandanus leaves on the north side, June 16.

Pitcairn Island: 12 specimens beaten from dead banana leaves on the south side, elevation 600 feet, June 14.

Rapa Island: one specimen collected at Putu Point, elevation 12 feet, July 15 by F. R. Fosberg; one specimen collected near Area, elevation 10 feet, June 30; and three specimens beaten from dead banana leaves, one quarter mile east of Area, near the seashore, July 1.

This species resembles *Proscopus veitchi* Jordan, with which it might easily be confused. Generally, however, it is somewhat darker colored and lacks the condensed pubescent areas on the prothorax so characteristic of *Proscopus veitchi*.

It is rather strange that I found this species only in Mangareva, Henderson, Pitcairn, and Rapa—four of the most southeastern islands of Polynesia. It is most certainly an introduced species, and I should expect it to have a widespread distribution in the Pacific. Further collecting should show that it has a distribution rather similar to that of *Proscopus veitchi*. Although the species occur under identical environmental conditions and are frequently taken together on one host plant, I collected only *Proscopus* in the Society and Austral Islands, where it is logical to expect both to occur. Both species are insects of the lowlands, living among such introduced and widespread trees as banana, *fei*, coconut, and pandanus. I have seen one specimen collected at Sovu, Lau, Fiji, Sept. 27, 1924, by E. H.

Bryan, Jr.; it further substantiates my belief that this genus and *Proscopus* have a similar distribution.

Genus DINEMA Fairmaire, 1849

I have seen no specimens of this monotypic genus which was redescribed by Jordan (Novitates Zool., 31:256, 1924) as follows:

"♂ ♀. Rostrum and frons vertical, forming an angle with the occiput; the rostrum somewhat inclined backward, much longer than broad, subcylindrical at base, widest at apex, apical margin very feebly incurved in middle. Antenna long in both sexes, inserted in sinus of eye, the scrobe covered by a tuberculiform lobe on the inner (frontal) side, segment 1 long, claviform, 2 short, 3 to 8 thin, long, 9 slightly but distinctly widened apically, 10 and 11 each shorter and broader than 9. Eye reniform, deeply incurved, the upper lobes approaching each other, the interspace being one-fourth the width of the rostrum (the latter measured at its narrowest point). Prothorax very much broader than long; carina antebasal, extending forward to apex, angle rounded."

From the description it is obvious that *Dinema* belongs to the *Proscopus-Neseonos-Jordanthribus* complex. If it were not for the lateral prothoracic carina extending to the apex, it might be considered quite close to *Jordanthribus*. The structure of the head and rostrum readily separate it from *Proscopus veitchi* Jordan and *Neseonos brunneus*. But in the illustration it greatly resembles *Proscopus*. If it were not for the fact that Jordan has examined this species and is the author of *Proscopus*, I might include *Proscopus veitchi* in *Dinema filicornis*.

6. Dinema filicornis Fairmaire: Rev. Mag. Zool., 54 (or 502?), pl. 11, fig. 17, 1849.

The type of this species was collected by M. Vesco on the freshly squared trunks of *Spondias dulcis*. Jordan records a damaged female in his collection at the museum at Tring.

Society Islands: Tahiti.

Genus PROSCOPUS Jordan, 1924

Head with the eyes convex, coarsely faceted, lateral, their dorsal margins near the top of the head, almost vertically placed, but slightly oblique, about two thirds as broad as high, the lower breadth almost twice that of the top, the greatest breadth somewhat less than half as broad as the distance between the scrobal tubercles; antennae inserted on the front at the inner dorsal corner of the eyes, the scrobe making a slight indentation in the upper half of the eye, scrobal tubercles frontal, large and conspicuous, the outer margins of the tubercles extending but slightly more laterally than the inner edge of the eye, the interscrobal area only about two thirds as broad as the broadest part of

the rostrum. *Rostrum* conspicuously flattened, continuously longitudinally concave dorsally with the head from the top of the scrobal tubercles to the apex, about twice as broad at the base of the mandibles as the distance from its ventral angulation with the head to the base of the mandibles, this distance hardly as great as that between the ventral angulation and the lower margin of the eye, the rostrum appearing longer, however, because it is continuous with the front of the head and the eyes are situated so close to the top of the head; with a sharply defined, conspicuously raised, lateral, frontal carina running from the scrobal tubercle to the base of the mandible and diverging distally; mandibles not toothed. *Antennae* reaching to the apex of the elytra in the female, more than twice as long as the body in the male; the segments in the male as follows: one twice as long as two, subcylindrical, excluding the basal peduncle, two less than one third as long as three and not broader, three longer than one plus two, three to eight similar, very slender and successively somewhat longer, nine similar to but slightly shorter than eight, nine about as long as ten plus eleven which are not expanded and similar in diameter to nine, ten somewhat longer than eleven; in the female segments three to nine are subequal in length, nine is somewhat longer than ten which is slightly shorter than eleven, nine to eleven slightly expanded distally. *Prothorax* transverse, the dorsal carina antebasal, forming a continuous curve at the side with the lateral carina which is continuous to the apex; without baso-lateral carinulae. *Scutellum* visible. *Elytra* subparallel-sided, twice as long as the prothorax, distinctly striate-punctate. *Legs* rather slender, the femora simple and not strongly clavate; tibiae slender, subcylindrical; first tarsal segment about as long as two plus three, two broader than long, three much broader than two and not immersed in it, fourth about as long as one, the claws with a subbasal tooth. *Sternum* with the fore coxae separated by about one fourth of the breadth of a fore coxa, mid and hind coxae more widely separated, for about the diameter of the apex of the tibiae; hind coxae transverse, almost reaching the elytra; metasternum between the mid and hind coxae longer than a metacoxa at the trochanter.

The genotype is the only known species in this genus. *Proscopus* is closely allied to *Neseonos* but the lateral pronotal carina, extending all the way to the apex, enables one to separate this genus from *Neseonos* offhand.

7. **Proscopus veitchi** Jordan: Novitates Zool., **31**:256, 1924; Insects of Samoa, **4** (2): 164, figs. 2, 3, 1928; (fig. 1, *b, p*).

Derm pale yellowish brown, rarely dark yellowish brown; pubescence pale yellowish or grayish, condensed on either side of the pronotal disk to form a somewhat oblique, pale area beginning in front of elytral interval four or five and continued to or past the middle, often with the pubescence somewhat similarly condensed along the median line, the areas between the longitudinal condensed lines of pubescence sparsely pubscent and therefore appearing as dark areas, the condensed pubescent lines and the dark median areas distinctly visible to the unaided eye; elytra with the pubescence comparatively dense and with dark spots here and there, often with small but distinct dark spots on the alternate intervals visible to the unaided eye, the sutural region and sides usually darker brown. Length, 1.8-3.25 mm.; breadth, 0.8-1.3 mm.

These characters together with those of the generic description will serve to distinguish this species. It is somewhat variable in dermal coloration, color pattern, and size. On an average basis it is smaller and paler than *Neseonos brunneus*.

This species was originally described from Fiji and later reported from Samoa and from the Marquesas. Since this paper was written, I have found the species in Honolulu. The Mangarevan Expedition procured 117 specimens in southeastern Polynesia in 1934 from which the following new host and distributional data are recorded. Unless otherwise stated, all the specimens were collected by me.

Society Islands:

Tahiti, two specimens from Tiupi Bay, Papeari, one from *Inocarpus edulis,* March 31 and one April 28; one specimen from Fautaua Valley, elevation 300 feet, March 3.

Raiatea: one specimen collected in 1926-1927 by J. W. Moore.

Flint Island: two specimens swept from grasses and low herbage, elevation 10 feet, Oct. 16.

Austral Islands:

Rimatara, one specimen swept from grasses and low herbage at Maraitere, elevation 25 feet, Sept. 5.

Raivavae, two specimens collected by C. M. Cooke, Jr., and D. Anderson near Unurai, elevation 100-200 feet, Aug. 3; one specimen swept from grasses and low herbage near Ahuoivi Point, elevation 5 feet, Aug. 9; one specimen swept from shrubs on Motu Tehau Islet, elevation 5 feet, Aug. 11.

Tubuai, five specimens swept from grasses and low herbage at Murivahi, elevation 10 feet, Aug. 16; one specimen swept from grasses and low herbage on Tapapatuai Islet, elevation 5 feet, Aug. 19; and one specimen collected on Rautaro Islet, elevation 5 feet, Aug. 19.

Rapa Island: nine specimens beaten from dead banana leaves one quarter mile east of Area, July 1; one specimen collected by C. M. Cooke, Jr., near Ahurei, elevation 100 feet, July 29; two specimens beaten from dead branches at Maitua, elevation 700-800 feet, July 2 and 10; one specimen collected at Morongota, elevation 700-800 feet, July 11; two specimens collected at Mangaeae, July 16; one specimen from dead pandanus leaves near Narioa Point, sea level, July 5; and one

specimen beaten from *Fitchia* on Karapo Rahi Islet, elevation 100-300 feet, July 18.

Mangareva Islands:

Mangareva, seven specimens beaten from dead branches and leaves near Rikitea, elevation 50 feet, June 4; one specimen collected near Rikitea, elevation 100 feet, June 9; two specimens beaten from dead branches and leaves on the south slope of Mount Duff, elevation 300-700 feet, June 4.

Agakauitai, one specimen swept from grasses and low herbage and 31 specimens beaten from dead banana leaves and dead coconut fronds, elevation 10 feet, June 8.

Taravai, 37 specimens beaten from dead coconut fronds on the northeast side, June 1; Akamaru, one specimen swept from grasses and low herbage at Koiovau, May 29; Aukena, one specimen swept from grasses and low herbage at Koiovau, May 29; and two specimens swept from grasses and low herbage on the northwest side, elevation 25 feet, May 25.

This series is the largest ever assembled.

Genus JORDANTHRIBUS, new genus

Head with the eyes elongate, about twice or almost three times as long as broad, not strongly convex, lateral, vertical, the dorsal apices almost reaching the top of the head, arcuate externally, sinuate internally, about half as broad as the distance between the tops of the eyes, the interocular area one third to about two times broader between the lower edges of the eyes than between the tops of the eyes, almost as broad as the lower margins of the eyes at the greatest breadth of the rostrum; antennae inserted on the front at the inner dorsal apex of the eye, the outer edge of the scrobe forming a distinct concavity near the dorsal apex of the eye, the inner edge of the scrobe produced into a distinct tubercle, the distance between the lateral margins of the tubercles somewhat greater than the distance between the dorsal corners of the eyes; the frons flattened and forming a rounded or rather sharp angle with the vertex. *Rostrum* from the ventral angulation with the head to the apex of the mandibles, three fourths to almost as long as the head, conspicuously flattened and continuous in dorsal outline with the frons, somewhat sexually dimorphic, flatter and somewhat longer on the male than female, usually conspicuously inclined ventro-caudad, laterally constricted on the sides and rather suddenly expanded on the sides at the apex, the dorsum, at least in the male, forming a distinct angle with the sides; mandibles sharply pointed and not toothed. *Antennae* reaching only to about the middle of the elytra in the female and almost or quite to the apex in the male; the segments in the male as follows: segment one slender, somewhat longer than the eye, as long as segments two plus three, arcuate or sinuous, not straight, two to seven inclusive slender, subequal in length, eight similar in shape to seven but shorter, eight to eleven subequal in length, nine to eleven but slightly broader than eight, not expanded, eleven sharply pointed; the female

with segments nine, ten, and eleven somewhat flattened and expanded, nine longer and fully twice as broad as eight. *Prothorax* transverse, the dorsal carina antebasal, continuously curved latero-anteriorly to form a lateral carina that does not reach past the middle of the side, without conspicuous or complete baso-lateral carinulae. *Scutellum* visible. *Elytra* twice or more than twice as long as the prothorax, subparallel-sided before the declivity; punctate-striate. *Legs* with the femora moderately strongly clavate; tibiae slender, subcylindrical, as long as the femora; tarsi with the first segment as long or longer than two plus three, two as long as broad or transverse, three free and broader than two, claws each with a sharp, submedian tooth. *Sternum* with the coxae distinctly and subequally separated, the fore coxae separated for about half the breadth of a fore coxa, hind coxae transverse, reaching about to the elytra; metasternum as broad between the mid and hind coxae as a hind coxa at the trochanter. *Venter* with the first ventrite slightly shorter behind the metacoxa at the trochanter than the second ventrite, segments two, three, and four successively very slightly shorter along the median line, five as long or somewhat longer than four.

Genotype: *Jordanthribus planifacietus,* new species.

This genus is allied to *Proscopus* and *Neseonos* but has the rostrum longer than either of those genera. From *Proscopus* it may be readily distinguished by the lateral prothoracic carina which does not extend beyond the middle, by the absence of prominent facial carinae, much shorter antennae and longer first antennal segment. The shorter antennae, longer first antennal segment, differently shaped eyes, different conformation of the head and rostrum, and shorter, lateral prothoracic carina will serve to separate this genus from *Neseonos.*

Only one species is described here, but I have another new species from Micronesia which will be described in a forthcoming paper.

This genus is obviously a recent introduction into southeastern Polynesia. I found the genotype in three archipelagos in Polynesia and I have specimens from Guam at the western border of Micronesia. This widespread, discontinuous distribution is not conducive to accurately placing the original home of the genus, but I believe that it will be found well developed in the Austro-Malayan subregion.

I take pleasure in combining Dr. Karl Jordan's name with *Anthribus* to form the name of this genus, as a token of appreciation to him who has done more than any other person in laying a sound foundation for the study of the Anthribidae and for the aid he has given me.

8. Jordanthribus planifacietus, new species (fig. 1, *i, l, q*).

Derm yellow, shiny, eyes black and sharply contrasted with the pale head, elytra occasionally with a dark area on the sides and more rarely at the suture near the middle; pubescence whitish or yellowish.

Head finely punctate and setose, the male with the crown horizontal from the base to the scrobal tubercles, the front there forming a sharp, acute angle with the crown, the line between the tubercles concave when viewed from above

and bearing six or seven very conspicuous, long, tapered setae, the outer ones each curved inward distally to meet the central ones at their apices; front very flat and forming a perfectly flat surface with the rostrum from the vertex to the rostral apex, the sides forming an angle with the dorsum, and concave below the eyes; the female with the crown rounded, and forming a rounded, obtuse angle with the front, without a conspicuous line of demarcation between the crown and front at the scrobal tubercles and without long setae there, the front continuously longitudinally concave with rostrum, slightly convex transversally. *Rostrum* with punctures and setae as on head, as long from ventral angulation with head to apex of mandibles as head in male, three fourths as long in female, very flat in male and with a fine carina dividing sides from dorsum running from inner margins of eyes almost to apex and with fine, erect, rather dense, hairlike setae along the carina, when viewed from front rather sinuously narrowing on the sides from base of eyes on head to near apex and thence suddenly flared out, the narrowest breadth somewhat more than half the greatest apical breadth; slightly transversally convex in female and without distinct lateral carinae and without a row of long setae at sides. *Prothorax* slightly broader than long (7:6), slightly transversally depressed before the base and middle; densely and minutely punctate; pubescence hairlike, anteriorly inclined, not forming condensed patches and not concealing derm, lateral carina forming broad and continuous curve with dorsal carina and extending half the distance between dorsal carina and side at lower margin of eye. *Elytra* three fourths as broad as long, twice as long as prothorax, subparallel-sided from the subtruncate base to apical declivity, shallowly punctate-striate, very slightly transversally depressed before middle; pubescence fine and hairlike, two or three rows to each interval, rather steeply inclined, not concealing the derm and not forming condensed areas. *Legs* finely, shortly, sparsely pubescent; first fore tarsal segment one third as long as a fore tibia. *Sternum* finely and shallowly punctate, shortly and sparsely setose. *Venter* minutely and inconspicuously punctate and setose. *Pygidium* slightly medianly grooved at base only, minutely punctate, sparsely setose, one third broader than long in both sexes. Length, 1.75-2.25 mm.; breadth, 0.8-1.0 mm.

Society, Austral, Mangareva, and Marianas Islands. Unless otherwise stated, all the following specimens were collected by me.

Mangareva Islands:

Agakauitai, holotype male and one male paratype beaten from dead banana leaves and dead coconut fronds, elevation 10 feet, June 8, 1934.

Taravai, allotype female beaten from dead coconut fronds on northeastern side, June 1.

Austral Islands:

Tubuai, one female paratype swept from grasses and low herbage on Tapapatauai Islet, elevation 5 feet, Aug. 19.

Maria, one female paratype from northeast islet, elevation 5 feet, Sept. 6.

Society Islands:

Tahiti, one male paratype from Arihiri, Pare, March 15, and one

female paratype collected at light at the same locality, March 14; one female paratype swept from grasses and low herbage at Tiupi Bay, Papeari, May 5.

Moorea, one female paratype from Afareaitu, elevation 10 feet, Sept. 28.

Marianas Islands:

Guam, three male paratypes and four female paratypes collected by R. L. Usinger at Machanao, June 5, 1936, two of the males and three females from dead leaves of a fallen tree, the other male and female beaten from the dried leaves of fallen branches.

The widespread distribution of this species indicates that it has been carried by man to many parts of the Pacific. The extremes in localities, Mangareva and Guam, are about 6,000 statute miles apart. It is probable that more collecting will result in the finding of this species on many more islands in Oceania.

The rather spectacular flat "face" and long rostrum of the male and the pale color of the derm make this species easily recognized among the Anthribidae of southeastern Polynesia.

Genus MAUIA Blackburn, 1885

Head convex; eyes lateral, convex, almost circular, but the lower margin slightly flattened, less than half as broad as the interocular area. *Rostrum* from the lower margins of the eyes to the apex of the labrum about two thirds as long as the head, about four fifths as broad as long, the longitudinal dorsal outline slightly concave below the eyes; mandibles concave internally and not toothed; antennae inserted at the sides of the base of the rostrum close to the lower, inner margin of the eye, the scrobe contiguous with the lower margin of the eye and with a rather short, elongate, tuberculiform, longitudinal ridge just below the inner margin of the eye. *Antennae* extending behind the base of the elytra in both sexes, but not past middle, with first segment stout, slightly shorter than second, second stouter at apex than third but very slightly longer, segments three to eight inclusive successively slightly shorter, nine somewhat longer than eight and subequal or slightly longer than ten, ten slightly shorter than eleven, nine and ten not triangular, eleven elliptical, nine to eleven forming a very loose, asymmetrical club, the emarginations at the sutures between the segments equally formed from either side. *Prothorax* distinctly transverse, dorsal carina basal or nearly so, but usually appearing subbasal owing to the tilting forward of the prothorax at death, lateral carina extending almost or quite to two thirds the distance from base to apex, forming a broad, slightly rounded, very obtuse angle with the dorsal carina, longitudinal lateral carinula forming a distinct acute angle internally with dorsal carina and a very obtuse angle with lateral carina. *Scutellum* distinct. *Elytra* subparallel-sided, base slightly and broadly emarginate from humeri to suture, somewhat more than twice as long as prothorax. *Legs* with the femora rather strongly clavate;

tibiae slender, fore pair about as long as the fore femora; first fore tarsal segment less than a third as long as a fore tibia, first tarsal segment slightly longer than segments two plus three, second segment slightly longer than three which is broader than two and not immersed in it, fourth segment about as long or slightly longer than two plus three, claws with a sharp subbasal tooth. *Sternum* with the fore coxae closely approximated, less than half as widely separated as the meso- and metacoxa which are subequally separated, hind coxae transverse, almost reaching the elytra; metasternum between the mid and hind coxae broader than a metacoxa.

The one species of this genus found in eastern Polynesia superficially resembles species of *Aethessa* or elongate *Araecerus* but is easily distinguished from those two genera. From the dorsal view it might easily be mistaken for *Proscopus* or *Neseonos* if it were not for the position of the dorsal prothoracic carina. Three species of this genus have been described. The species listed here is the genotype; the other species are from New Guinea and the Malay Peninsula.

9. **Mauia subnotatus** (Boheman).

Araecerus subnotatus Boheman: Eugenies Resa, 116, 1859.
Mauia satelles Blackburn: Roy. Soc. Dublin, Trans., 3:195, 1885.
Contexta murina Jordan: Deutsche Ent. Zeitsch., 78, 1902.

The characters summed up in the key and generic description obviate the necessity of a specific description of this widespread species. The color varies from testaceous through reddish brown to piceous. The elytral striae are distinctly impressed and the squamules on the intervals are rather coarse. The whole of the elytra is usually tessellated with patches of pale and dark squamules. Length, 2.5-3.5 mm.; breadth, 1.0-1.5 mm.

This species has been previously recorded in southeastern Polynesia only from Eiao in the Marquesas and Moorea in the Society Islands. It has not been recorded in Hawaii since a unique specimen was taken by Rev. Thomas Blackburn previous to 1885 on the island of Maui (hence the generic name). However, I have seen specimens collected since 1917 from localities on Hawaii, Oahu, and Kauai. It is a species with a wide distribution in both the Pacific and the Old World tropics.

During the course of the Mangarevan Expedition, I collected 32 specimens as follows:

Society Islands:

Tahiti, one specimen collected near Papeete, March 23.

Moorea, one specimen from Faatoai Valley, elevation 200 feet, Sept. 23.

Tuamotu Archipelago:

South Marutea, one specimen from the northwest islet, May 22.

Mangareva Islands:

Mangareva, 17 specimens beaten from dead leaves and dead branches near Rikitea, elevation 50 feet, June 4; six specimens from Rikitea, 100 feet, June 9; three specimens beaten from dead branches and dead leaves on the south slope of Mount Duff, elevation 300-700 feet, June 4.

Pitcairn Island: two specimens beaten from dead banana leaves on the south side, elevation 600 feet, June 14.

Austral Islands:

Maria, one specimen beaten from a dead pandanus cone, on the northeast islet, elevation 5 feet, Sept. 6.

Genus ARAECERUS Schönherr, 1826

Head continuously convex in dorsal outline with the rostrum; eyes rather large, lateral, entire, round or oval, strongly convex, laterally protuberant, half or more than half as broad as the interocular area; antennae inserted at the inner lower margins of the eyes, upper margin of scrobes contiguous with eye, inner margins of scrobes not conspicuously elevated, not tuberculiform, the interscrobal distance distinctly narrower than the interocular area. *Rostrum* from scrobes to base of labrum less than half as long as head and there less than half as long as broad, dorsally convex, rather thick; mandibles with an acute antemedian tooth. *Antennae* not or hardly reaching past the base of the prothorax; first segment arcuate, stouter and slightly longer than two, two shorter and somewhat stouter than three, three to eight similar in shape but each successively shorter, nine, ten, and eleven expanded and flattened to form a loose club, these segments subequal in length, eight and nine subequal in length. *Prothorax* transverse, convex, dorsal carina basal, lateral carina short, not reaching the middle of the side and forming either an oblique or obtuse angle with the dorsal carina, baso-lateral carinulae indistinct. *Scutellum* visible. *Elytra* subparallel-sided before the declivity, punctate-striate, about twice as long as the prothorax. *Legs* rather slender, tibiae subcylindrical, as long as femora; first tarsal segment longer than two plus three, two longer than broad, longer than three, three rather small, not or hardly broader than two, claws each with a sharp subbasal tooth. *Sternum* with fore coxae larger and more prominent than mesocoxae, very narrowly separated, mid and hind coxae distinctly and subequally separated, hind coxae transverse, almost reaching the elytra; metasternum between mid and hind coxae broader than a metacoxa at the trochanter.

Because of its basal dorsal prothoracic carina in combination with its densely pubescent body, this genus can be confused only with

Mauia in the eastern Polynesian fauna. Its stouter form, shorter antennae, shorter prothoracic carina, toothed mandibles and shorter second antennal segment will separate *Araecerus* from *Mauia.*

Araecerus is predominently an Indo-Australian genus. Some species, such as the two discussed here, are of some economic importance. The individuals of the species jump rapidly and excitedly when disturbed. Although the number of described species is not great, much taxonomic difficulty is encountered in studying them. The two species found in our fauna are very closely allied and can be separated only after careful study and comparison. They may be distinguished by the following key:

1. Segments of the antennal club strongly asymmetrical, each almost straight on one side and strongly convex on the other (fig. 1, *h*), second antennal segment usually only about half as long as the third; mesocoxae and fore tibiae of the male unarmed........................... **A. fasciculatus.**
2. Segments of the antennal club almost symmetrical, each rounded on either side (fig. 1, *g*), second antennal segment about three fourths as long as the third; mesocoxae of male with a conspicuous conical tooth; fore tibiae of male armed below with a small but rather strong apical mucro and usually with numerous, variable teeth and longer, hairlike, erect pubescence than dorsally.................................... **A. vieillardi.**

The important differences between the two species are given in the key, therefore I shall not give a detailed description of each species.

10. Araecerus fasciculatus (De Geer) (fig. 1, *h*).

Curculio fasciculatus De Geer: Mem. Ins., **5**:276, tab. 16, fig. 2, 1775.

See Coleopterorum Catalogus for detailed synonymy.

This species has become almost cosmopolitan. It is an important pest of coffee, cocoa, nutmeg, and similar products. This species is known in southeastern Polynesia only from Tahiti, where I collected one specimen from a legume pod in Fautaua Valley, March 7, 1934, and swept two specimens from a legume at Arue, elevation 50 feet, March 6. The legume was probably a *Crotalaria.* It is evident that this species has not become well established, because only three of the 143 specimens of *Araecerus* collected by the Expedition belong to *A. fasciculatus.*

11. Araecerus vieillardi (Montrouzier) (fig. 1, *d, g*).

Uradon vieillardi Montrouzier: Ann. Ent. Soc. France, 873, 1860.

This variable species is very common and widespread in the

Pacific, reaching westward into the Philippines and eastward to Hawaii and the Mangareva Islands. The small teeth on the inner sides of the fore tibiae are often obsolete in small males. The length ranges from 2 to 4 mm.

This species has heretofore been recorded only from the Society and Marquesas Islands in southeastern Polynesia. The Mangarevan Expedition procured 143 specimens of this species as follows. Unless otherwise stated all specimens were collected by me.

Society Islands:

Tahiti, 47 specimens beaten from dead leaves and seed capsules of *Hibiscus tiliaceus,* 1.5 miles northeast of Papeete, elevation 25 feet, March 1, 1934; two specimens taken at the same time and place by sweeping; three specimens swept from grasses at Pirae, Parc, March 12; three specimens swept from a legume at Arue, elevation 50 feet, March 6; one specimen from Arihiri, Pare, March 17; one specimen taken from the pod of a legume in Fautaua Valley, March 7; and one specimen taken at Tiupi Bay, Papeari, April 11.

Moorea, two specimens swept from grasses and low herbage at Tehau Point, elevation 10 feet, Sept. 24; one specimen from Faatoai Valley, elevation 200 feet, Sept. 23; one specimen from Orufara Valley, elevation 200-400 feet, Sept. 22.

Huahine, one specimen collected by Y. Kondo on the north slope of Mount Taiahi, elevation 600-700 feet, Oct. 1.

Raiatea, two specimens swept from grasses and low herbage on the northwest side of Faaroa Bay, elevation 25 feet, Oct. 6; three specimens collected at the same place and date by Y. Kondo, elevation 300-500 feet; one specimen collected by C. M. Cooke, Jr., and Y. Kondo in the valley east of Mount Orotaia, Oct. 5.

Borabora, one specimen from the west slope of the mountain north of Mount Pahio, elevation 600-800 feet, and two specimens collected by Y. Kondo on the west slope of Mount Pahio, elevation 300 feet, Oct. 13.

Austral Islands:

Maria, one specimen collected on the northeast islet, elevation 5 feet, Sept. 6.

Rimatara, four specimens swept from grasses and low herbage on Oromana Hills, elevation 25 feet, Sept. 4.

Rurutu, two specimens from the southwest slope of Mount Manureva, elevation 1,000 feet, Aug. 25; four specimens from Uopepe Valley, elevation 100 feet, Aug. 27; one specimen swept from grasses and low herbage on Mount Manureva, elevation 1,000 feet, Aug. 28; two specimens swept from *Crotalaria* on the south slope of Mount Teape, elevation 800 feet, Sept. 2; one specimen from fallen fruit of *Inocarpus edulis* at Moerai, elevation 50 feet, Aug. 26.

Tubuai, four specimens from Murivahi, elevation 10 feet, one swept from grasses and low herbage, Aug. 16; two specimens swept from grasses and low herbage on Tapapatauai Islet, elevation 5 feet, Aug. 19; one specimen from the southeast ridge of Mount Taita, elevation 1,200 feet, Aug. 20; one specimen from the southeast slope of Mount Turivao, elevation 1,200 feet, Aug. 23.

Raivavae, four specimens beaten from dead leaves and branches on the south slope of Pic Rouge, elevation 200-400 feet, Aug. 5; two specimens swept from grasses and low herbage at Raiurua, elevation 5 feet, Aug. 5; one specimen from near Arepua, elevation 100 feet, Aug. 6; one specimen beaten from *Metrosideros* on the southwest slope of Mount Hiro, elevation 1,200-1,300 feet, Aug. 10; five specimens swept from shrubs on Motu Tehau Islet, elevation 5 feet, Aug. 11; three specimens swept from grasses and low herbage near Anatonu, elevation 5 feet, Aug. 12; one specimen collected by D. Anderson and me from dead, rotten leaves of *Hibiscus tiliaceus* near Ahuoivi Point, elevation 5 feet, Aug. 9, and one specimen with the same data swept from grasses and low herbage.

Rapa Island: eight specimens beaten from dead branches of *Homolanthus* at Maitua, elevation 700-800 feet, July 2; five specimens beaten from *Hibiscus tiliaceus* near Area, elevation 10 feet, July 1, and two with the same data taken on July 30; one specimen beaten from ferns in the southeast valley of Mount Ororangi, elevation 600-700 feet, July 3; and one specimen collected by D. Anderson near Area, elevation 400 feet, July 30.

Tuamotu Archipelago:

Tepoto, one specimen swept from grasses and low herbage near the middle of the island, May 16.

Mangareva Islands:

Mangareva, one specimen from the northeast slope of Mount Duff, elevation 100-500 feet, May 23; seven specimens swept from grasses and low herbage near the convent, elevation 300 feet, May 24; 12 specimens swept from grasses and low herbage, May 25, six of these from near the chapel on Teonekura Point, elevation 300 feet, five from near Roruu at the same elevation, and one from near Atifuiti; 12 specimens beaten from dead branches and leaves on the south slope of Mount Duff, elevation 300-700 feet, June 4, and one specimen with the same data collected at an elevation of 50 feet near Rikitea; two specimens from *Asplenium nidus* on the south side of Mount Mokoto, elevation 1,000 feet, June 6; and one specimen collected by D. Anderson at the same locality, June 7.

Taravai, 11 specimens swept from grasses and low herbage near Taravai Village, June 1, and one specimen beaten from a dead coconut frond on the northeast side, June 1.

Aukena, eight specimens swept from grasses and low herbage on the northwest side, elevation 5-20 feet, May 25, and two specimens swept from grasses and low herbage at Koiovao, May 29.

Akamaru, three specimens swept from grasses and low herbage on the north side, May 29.

Agakauitai, 15 specimens swept from grasses and low herbage, elevation 10 feet, June 8.

Oeno Island: seven specimens taken from low herbage, June 23.

Pitcairn Island: seven specimens swept from grasses and low herbage, on the north side, June 13; two specimens beaten from *Metrosideros* on south side, elevation 500 feet; five specimens swept from grasses and low herbage, elevation 700-900 feet, June 14.

Henderson Island: 11 specimens collected on the northeast side at 100 feet elevation as follows: seven beaten from shrubs June 19, one taken June 21, and three beaten from shrubs one quarter mile inland, June 19.

I have also seen specimens from Makatea in the Tuamotu Archipelago and from Rarotonga in the Cook Islands.

Genus MELANOPSACUS Jordan, 1924

Head concealed from above by the prothorax; eyes rather large, slightly convex, situated on the sides of the front, entire, posterior margins close to or contiguous with anterior margin of pronotum, about as long as interocular

area; antennae inserted just above the inner lower corner of the eyes, scrobes foveaform, their upper margins contiguous with eyes, without enlarged tubercles. *Rostrum* continuous in dorsal outline with the frons, much shorter than head, hardly as long or but slightly longer from the ventral angulation with the head to apex of mandibles than the distance from ventral angulation to eyes, fully twice as broad as long; mandibles not toothed. *Antennae* not or hardly reaching past posterior margin of prothorax, segment one about as long as or but slightly longer than two, two longer than three, segments three to eight each successively shorter, nine, ten, and eleven subequal, each about as broad as long, conspicuously flattened, nine fully twice as broad as eight. *Prothorax* large, transverse, dorsal carina basal, lateral carina not extending past the middle, forming a sharp, acute angle with dorsal carina, without visible baso-lateral carinulae. *Scutellum* invisible. *Elytra* convex, about as broad as long, only about one and a half times as long as prothorax. *Legs* with femora rather stout, tibia somewhat expanded distally, as long as femora; first tarsal segment longer than second which is about as long as broad, three free, broader than two, four longer than three, claws each sharply toothed. *Sternum* with fore coxae narrowly separated, the fore and mid coxae closely approximate, mid and hind coxae distinctly and subequally separated; hind coxae transverse, reaching metepisterna; metasternum between the mid and hind coxae narrower than breadth of a metacoxa at the trochanter.

The only genus that *Melanopsacus* might be confused with in our fauna is *Cisanthribus,* but on that genus the lateral prothoracic carina extends all the way to the apex, instead of not passing the middle as on *Melanopsacus.* The species of both these genera in our fauna are very small, strongly convex, highly polished, black insects.

This is predominantly an Indo-Austro-Malayan genus. Several species have been described from Samoa and Fiji; the following new species is the first recorded from eastern Polynesia.

12. **Melanopsacus rapaae,** new species (fig. 1, *r*).

Derm shiny black, appendages diluted with red; pubescence white or gray, not forming patterns.

Head finely, densely, subconfluently, reticulately punctate, pubescence fine and inconspicuous; eyes vertical, oval, somewhat flattened on inner side; scrobes with inner margins slightly raised. *Rostrum* continuously punctate and pubescent with head. *Antennae* with first segment elongate oval, slightly longer than the rather similarly shaped second segment, second segment fully twice as broad as third and about as long as three plus half of four; club rather symmetrical, the terminal segment broadly oval. Prothorax one sixth broader than long, base subtruncate, arcuate on sides and slightly convergent distally to broadly rounded apex; very densely, minutely but rather coarsely, reticulately punctate giving a shagreened appearance; pubescence evidently somewhat denser than on the elytra, hairlike, prostrate; lateral carina forming a sharp angle internally and externally with dorsal carina, the point produced slightly backward and downward. *Elytra* almost as broad as long, about two sevenths longer than prothorax, strongly convex dorsally and laterally; minutely and confusedly punctate throughout, not striate nor serially punctate; pubescence rather inconspicuous, very fine, prostrate, and scattered. *Legs* with first fore

tarsal segment one third as long as a fore tibia. *Sternum* with fore coxae almost contiguous, the prosternum before coxae as long as first three ventrites along median line, convex, densely punctate; mid coxae not separated from fore coxae by more than half the diameter of coxa; metasternum between mid and hind coxae less than half as broad as a metacoxa at the trochanter. *Venter* finely and densely punctate throughout, finely and inconspicuously pilose. *Pygidium* three fourths as long as broad, the apex broadly and evenly rounded; finely and densely punctate; pile very fine and inconspicuous. Length, 1.5 mm.; breadth, 0.8 mm.

Rapa Island: Holotype female (?) beaten by me from dead branches of *Sclerotheca* on the east ridge of Mount Perahu, elevation 1,400-1,500 feet, July 28, 1934.

Dr. Jordan, who has kindly examined this specimen, states that it is nearest to *Melanopsacus stibbus* Jordan, 1937; but the shagreened, densely punctate pronotum, confusedly punctate elytra and the shape of the angle between the dorsal and lateral carinae will serve to separate the species.

The fifth ventrite is distinctly longer than the fourth and, together with the convexity of the abdomen, leads me to believe that the holotype is a female.

Genus CISANTHRIBUS, new genus

Head concealed from above by prothorax; eyes protuberant, strongly convex, coarsely faceted, situated on the sides of the head at base of rostrum, slightly transverse, entire; interocular area about one and a half times as broad as eye; antennae inserted at inner edge of eye; scrobe foveaform, its dorsal margin contiguous with inner edge of eye, its inner margin cariniform and with a small tubercle; interscrobal distance much narrower than interocular area. *Rostrum* very short, distance between scrobes and the base of the labrum but slightly more than half the length of head, more than twice as broad as long, excluding mandibles which have a minute antemedian tooth and a pair of minute basal denticles and are longer than rostrum. *Antennae* not or hardly reaching past posterior prothoracic margin; the segments as follows: one about as long as two, three and four together, two as long or slightly longer than three plus four, at least twice as broad as three, four to eight rather similar in shape and subequal, nine, ten, and eleven forming a compact, asymmetrical club, the inner side almost straight, the outer side deeply serrate, nine and ten subangular, about as broad as long, ten subtruncate at apex. *Prothorax* strongly convex, strongly transverse; the dorsal carina basal and contiguous with the base of the elytra, fine, the lateral carina forming nearly a right angle with dorsal carina but joining the true basal carina behind dorsal carina and extending anteriorly to apex. *Scutellum* invisible. *Elytra* strongly convex, about as broad as long, more than twice as long as prothorax, very tightly joined to and slightly overlapping the extreme base of the prothorax. *Legs* with femora stout but not clavate; tibiae slightly shorter than femora, subcylindrical and evenly expanded distally; tarsi with first segment shorter than next two combined, second transverse, third broader than two, free and transverse, claws subbasally toothed. *Sternum* with fore coxae very narrowly separated, mid

and hind coxae distinctly and subequally separated, the fore coxae separated from mid coxae by a distance somewhat less than the diameter of a fore coxa; metasternum between mid and hind coxae extremely narrow, hind coxae globular, as broad as long, subequal in size with mid coxae. *Venter* with segments appearing somewhat telescoped beneath, narrower at the middle than on the sides. *Pygidium* strongly inclined ventro-anteriorly.

Genotype: *Cisanthribus convexus,* new species.

In eastern Polynesia, this genus most closely resembles *Melanopsacus* but is not closely allied to that genus. The complete lateral prothoracic carina and the globular hind coxae will alone separate *Cisanthribus* from *Melanopsacus.*

This genus is the only member of the anthribid fauna of eastern Polynesia in which the hind coxae are globular and similar to the mesocoxae instead of being transverse and extending laterally almost to the elytra. The single species in our fauna so closely resembles some convex members of the Ciidae that a careful examination is necessary to ascertain the correct family of the species.

Cisanthribus is evidently most closely allied to the Central American genus *Acaromimus* Jordan (Biol. Centr. Amer., 1907), but may be distinguished from that genus by its lateral prothoracic carina which extends straight to the anterior margin; in *Acaromimus* it passes a little beyond the middle and is then upturned.

13. **Cisanthribus convexus,** new species (fig. 1, *f, s*).

Derm shiny black with appendages reddish, without vestiture.

Head convex, minutely punctate, without setae; eyes slightly broader than long, horizontally placed, only about half as broad as the interocular area; interscrobal area slightly more than half as broad as the interocular area. *Rostrum* minutely punctate like head, slightly sinuous but subtruncate at apex. with some long setae at apex and on labrum. *Antennae* with first segment arcuate, evenly expanded from base to apex, as long as two plus three plus four, two as long as three plus four, subtruncate at apex, about as broad as the length of three, three slightly longer than four, four to eight subequal in length, nine as long as seven plus eight and slightly longer than ten, as broad at apex as long, ten distinctly transverse, as broad at apex as nine, eleven slightly longer than ten, somewhat subquadrate but roundly emarginate at apex. *Prothorax* two fifths broader than long, almost hemispherical in lateral outline; very minutely punctate; dorsal carina very fine and inconspicuous, the lateral carina well defined and sharply dividing the pleurae from dorsum, forming a slightly obtuse angle with dorsal carina; pleurae forming an angle with dorsum at carina. *Elytra* but slightly longer than broad, two and two thirds as long as prothorax, strongly convex, subcontinuously convex in longitudinal dorsal outline with pronotum, base subtruncate, strongly rounded on sides from base to apex, conspicuously carinately margined on sides; minutely and confusedly punctate, not striate nor serially punctate. *Legs* with first fore tarsal segment hardly as long as apical breadth of fore tibia, hardly longer than second segment

which is transverse and shorter than third. *Sternum* with fore coxae separated by only about one third the breadth of a coxa; mesosternum produced into a tuberculiform process between anterior part of mesocoxae; metasternum between mid and hind coxae only about one sixth as long as a metacoxa. *Venter* sparsely and minutely punctate. *Pygidium* convex, smooth and shiny, truncate at apex in female and one fourth broader than long, somewhat longer and with apex rounded in male, apex on a line perpendicular with apical margin of third ventrite at elytra. Length, 1.25-1.30 mm.; breadth, 0.75-0.90 mm.

Society Islands:

Tahiti, holotype male found among dead leaves on the ground 6 kilometers from the sea, elevation 300 meters, Nov. 7, 1928; allotype female with the same data but from dead wood of *Inocarpus edulis*; both collections by A. M. Adamson.

Moorea, two paratypes from dead banana leaves, 3 miles from the sea in Faaroa Valley, elevation 1,000 feet, Dec. 4, 1928; collected by A. M. Adamson.

This tiny, glabrous, shiny black species can easily be recognized among the Anthribidae of eastern Polynesia. Its resemblance to such Ciidae as the Hawaiian *Apterocis ephistemoides* (Sharp) is quite remarkable.

SPECIES OF UNCERTAIN STATUS

The following two species were described by Fairmaire from Tahiti in 1849. Neither Dr. Jordan nor I know of any specimens that have been identified as these species. Dr. Jordan has tried to locate the types in the collections of the National Museum at Paris and that of René Oberthür but has failed. It is most probable that the types of these two species have been lost or destroyed together with many other Fairmairean types.

14. **Rhinobrachys asperulus** Fairmaire: Rev. Mag. Zool., 55 (or 503?), 1849.

A free translation of the generic description reads as follows:

Rhinobrachys, n.g.—Rostrum flat, short, slightly depressed at the middle, nearly rounded at the apex. Head rather large, eyes small. Antennae inserted nearly at the apex of the rostrum, slightly on the upper side, without scrobes, a little longer than half the body. First segment large, swollen; the second smaller, but large and swollen; the following, to the ninth, nearly alike, filiform, very elongate triangular; the tenth and eleventh larger and thicker; all the segments are pilose. Prothorax a little longer than broad, strongly rounded on the sides at the middle, a little more narrowed in front than behind. Elytra hardly longer than the prothorax and rostrum together, a little broader than the prothorax, straight on the sides, slightly convex, truncate, shorter than the abdomen. Legs short, robust, femora swollen, especially the fore ones.

The specific description, exclusive of the Latin diagnosis, is as follows:

Length 2 1/3 mm. Pale brown, head and prothorax covered with fine asperities, all of the body covered with a very short, slightly dense pubescence. Elytra slightly convex, nearly straight on the sides, lined with rather large punctures.—Tahiti.—Taken a single time in a flower of *Crataeva religiosa* (Capparidaceae) in December.—M. Vesco.—This insect recalls slightly the form of *Platyrhinus,* but one cannot see a scrobe on either side of the rostrum, and the elytra do not all extend to the extremity of the abdomen.

The mode of insertion of the antennae and the asperate head and prothorax are characters not displayed on any species known to me. I had at first considered that this species might be *Mauia subnotatus* (Boheman), but upon examination it was found that Fairmaire's insect must have been quite different.

Tropideres lutatus Fairmaire: Rev. Mag. Zool., 56 (or 504?), 1849.

From the description, I have concluded that this species is most probably a synonym of the common *Araecerus vieillardi* (Montrouzier), and until I have been otherwise convinced, I shall consider it such. A free translation of Fairmaire's original description is as follows:

Length 3 mm. Dark reddish brown, covered with very dense yellowish gray pile, condensed in spots in places; nearly cylindrical in form; elytra punctate, striate, invisible under the pile. Antennae slender, slightly surpassing the prothorax, ferrugineous, the last three segments swollen. Under side of the body blackish brown, the gray pile short, slightly dense; legs reddish, the anterior ones longer than the others, the first segment of the tarsi as long as the others together. On freshly squared trunks of *Spondias dulcis*. Tahiti, M. Vesco.

The only members of the anthribid fauna of Tahiti that fit into a group of densely pilose, spotted, 3 mm. long species with the antennae but slightly passing the posterior margin of the prothorax are *Mauia subnotatus* (Boheman) and the two species of *Araecerus*. The first tarsal segment of *Mauia* is shorter than the following segments, and hence this character excludes *Mauia*. The first tarsal segment is as long as the following segments in *Araecerus*. Fairmaire's type was taken in the lowlands from the introduced tree, *Spondias dulcis,* in which habitat *Araecerus vieillardi* abounds. Although possible, it is highly improbable, because of the rareness of *A. fasciculatus* and the common occurrence of *A. vieillardi,* that this species is a synonym of *A. fasciculatus.*

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV March, 1939 Number 14

Fouling Organisms in Hawaii

By

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and

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INTRODUCTION

This report on fouling organisms is based primarily upon investigations in Kaneohe Bay, Oahu, which were initiated by C. H. Edmondson in March 1935 and are still in progress. In September 1935, W. M. Ingram began a parallel two-year study of such organisms in Kaneohe Bay and Pearl Harbor. However, the Pearl Harbor station was abandoned after one year because of unsuitable conditions. Studies were then centered in the Kaneohe Bay area, supplemented by casual observations in other localities. Brief preliminary statements on the progress of these investigations were made in 1937 by Edmondson in a published report (13)[1] and by Ingram in an unpublished thesis (19). The present account brings together the most important data and results collected over a period of three years.

The windward shore of Oahu was selected for these studies because most previous observations had been made on the leeward shore, in Pearl Harbor and Honolulu Harbor. The field work was done at the end of a pier extending about 400 yards out from the shore of the Territorial Fish and Game Farm in Kaneohe Bay, a potential harbor on the northeast coast. Here the bottom is muddy and sandy with some outcropping of coral rocks nearby. The water in this general area is about one fathom deep at high tide while a dredged chan-

[1] The numbers in parentheses refer to the Bibliography (p. 290).

nel near the end of the pier increases the depth by several feet, thereby enhancing the value of the locality for experimental purposes. The station is sufficiently isolated to assure a minimum degree of disturbance by marauders which is a factor of no little importance to long-time records.

The primary purpose of the investigations was biological. Special attention was given to the kinds and species of fouling organisms, their seasonal succession, and ecology. Early developmental stages were observed as far as possible, and the rate of growth under varied conditions recorded. Consideration was also given to various experimental and artificial means of preventing or at least discouraging the attachment of sedentary organisms. Methods employed included the use of panels of wood, metal, glass, and composition materials, floated on the surface or suspended in the water to serve as cultch for the organisms. "Masonite" was used extensively, and "Wolmanized" wood was tested for its ability to repel organisms when submerged in sea water. At intervals the panels were lifted temporarily for observation and measurement of affixed forms, or were removed permanently to be photographed and studied more completely.

To study normal fouling the surfaces of panels were untreated. Many non-toxic paints and coatings were utilized to determine the effect of different colors on the settling and attachment of sessile forms. To some of the cheaper non-toxic commercial paints various poisonous chemicals were added, singly or in combination, in order to note the tendency of such mixtures to hinder fouling. Numerous paints recommended by manufacturers as having antifouling properties were tested for their relative efficiency.

Larvae and adults of certain sessile organisms were subjected to laboratory experiments involving desiccation, resistance to dilute sea water and to range of temperature, and their relative capacity to survive when exposed to various toxic agents.

From the earliest period of navigation seafarers have had to contend with conditions similar to those which cause immense economic loss to the shipping industry of today. An early method employed to protect the wooden hulls of ships from sedentary organisms was to sheath the under surfaces with lead fastened by copper nails, or otherwise provide false external bottoms, which when heavily fouled could be removed and replaced. On the introduction of ships with metal hulls, external sheathing became impracticable and an attempt

was made to prevent the attachment of organisms by coating the surfaces exposed to sea water with poisonous paints or other toxic preparations. This led to the manufacture of many substances recommended as repellents of marine organisms. Visscher (32) records that Young of England found more than 300 patents had been issued in that country prior to 1867 for antifouling coatings, and Gardner (14) reports that more than 160 such patents had been granted in the United States previous to 1922. The ingredients of these preparations range from garlic to tobacco juice and from arsenic to mercury.

While attempts to discourage fouling have been almost wholly confined to rendering under-water surfaces obnoxious to sedentary organisms, recent biological investigations of the organisms themselves have added valuable information toward a fuller knowledge of the problem if not toward its solution. Studies of the early development, the life cycle, the rate of growth and other biological phases of fouling organisms have contributed much toward an understanding of their behavior both before and after the time of attachment. Such investigations have been conducted in many parts of the world. Data are recorded for European waters by Orton (28), Neu (27), Moore (24, 25), Bassindale (7) and others. On the Atlantic coast of the United States, contributions have been made by Parker (29), Visscher (32, 33), Visscher and Luce (34), Grave (15), Herz (16), and others. These include extensive researches carried on under the direction of the United States Navy. In the Pacific Ocean, Angst (2) and Hilen (17) studied the relation of bacteria to fouling at Seattle, Washington; Johnson and Miller (20) observed the seasonal settlement of sedentary forms at Friday Harbor, Washington; Coe (9) and Coe and Allen (10) determined the seasonal attachment and rate of growth of certain sessile marine organisms at La Jolla, California. A comprehensive study of fouling organisms has been initiated by the Scripps Institution of Oceanography in cooperation with the United States Navy's Bureau of Construction and Repair.

In Hawaiian waters, in addition to observations made by the United States Navy at Pearl Harbor, owners of private yachts and other marine craft have for many years known the constant care required to keep their boats in good condition. J. R. Macauley, Surveyor of the Bureau of Shipping in Honolulu about 15 years ago, experimented on the bottom of the steamer *C. R. Bishop* by painting a 12 foot square area with a solution of white arsenic, zinc, and

Portland cement mixed in boiled linseed oil, the rest of the bottom being painted with a copper paint. The result is quoted from the Bulletin of the American Bureau of Shipping, May-June 1923: "After 9 months the 12 foot square area was as clean as a hound's tooth while the rest of the bottom was covered with an inch of coral."

Lissmann's investigations (21) on fouling organisms initiated in the North Sea were continued in the Red Sea and the Indian Ocean, but the results are unpublished.

In studies of fouling organisms in relation to oyster culture in Japan, Miyazaki (23) suggests that the possible retardation of shell-fish growth may be due to masses of sedentary forms on the oyster shells.

Sedentary marine organisms which cause the fouling of ships' bottoms are of similar groups wherever they are found. Although ecological conditions may determine the abundance or prevalence of certain forms and specific variations may occur in different localities, in general the same phyla and even the same genera are represented in waters of both tropical and colder latitudes. Fouling organisms proper include those forms which become attached to the basic surface either directly or indirectly by fixing themselves to other organisms. Frequently a thick mass is formed by organisms piling up on each other, causing the underlying forms to maintain themselves with difficulty or to be completely smothered. A dense coating of barnacles is often covered by a layer of encrusting bryozoans, the tests of the sessile crustaceans being entirely enclosed except for the apices where activity of the branchial processes maintain contact with the water for nutrition and respiration. Over this second encrustation a coating of compound ascidians often develops, spreading as a thin, soft layer or massing into compact colonies several inches in diameter. Interspersed may be colonies of *Bugula,* serpulid worms, bivalve mollusks, algae, and other sedentary forms. Among these, numerous free living organisms find shelter and sustenance, and after a few weeks a highly complex organic association adheres to a submerged panel or the under-water surface of a boat.

DISCUSSION OF FOULING ORGANISMS

In Kaneohe Bay organisms comprising the fouling complex as indicated by test panels included the following species. *Balanus amphitrite* Linnaeus, with two or three varieties, was the most common

species of barnacle; isolated specimens of *Chelonibia testudinaria* (Linnaeus), typically attached to turtles, also occurred. Colonial bryozoans included many bushy colonies of the cosmopolitan form, *Bugula neritina* (Linnaeus)[2]; sporadic occurrences of a repent species of *Amathia*; several encrusting forms of which *Schizoporella unicornis* (Johnston) (pl. 1, *C, D*) was the most common sometimes completely covering exposed surfaces, while *Rhynchozoon nudum* Canu and Bassler occasionally settled on wood and metal panels; and the inconspicuous forms, *Aetea truncata* (Landsborough) and *Catenaria lafonti* (Audouin).

Serpulid worms are usually constant and conspicuous members of fouling associations. In Kaneohe Bay, two widely distributed species, *Hydroides norvegica* Gunnerus and *H. lunulifera* (Claparède), were abundant throughout the year (pl. 2, *A, B*). Masses of slender, fragile tubes of *Salmacina dysteri* Huxley (pl. 2, *C*) and at least two undetermined species of serpulid worms occasionally settled on the panels. A species of *Spirorbis* was first observed on panels during the early spring of 1938. Because of its small size and scarcity it had no significant part in the fouling complex.

Among mollusks considered as fouling organisms the most common in this locality was a smooth-shelled oyster, *Ostrea thaanumi* Dall, Bartsch, and Rehder, which was abundant on panels during nearly all months of the year (pl. 3, *A*). A small "pearl oyster", *Pinctada nebulosa* Conrad, which is plentiful in Pearl Harbor and Kaneohe Bay, occasionally adhered to submerged panels. This species, which develops a shell 3 or 4 inches broad, is potentially a significant fouling organism but seldom becomes attached to the bottom of boats in great numbers.

Ascidians, both simple and compound, often comprised a prominent part of the accumulated organic matter on test panels at the Kaneohe Bay station. The rapidly spreading compound forms, of which there are apparently numerous species, may form a superficial layer over barnacles, mollusks, worm tubes, and bryozoa or become clumped into compact, spheroidal masses (pl. 3, *B*). Simple ascidians with transparent tunics frequently attained a length of 18 mm. in 48 days, and specimens from 60 to 70 mm. long have been taken from panels submerged for 14 months. The maximum development

[2] For the determination of Bryozoa mentioned in this report we are indebted to Professor Raymond C. Osburn of Ohio State University, Columbus, Ohio.

of compound ascidians occurred during the spring and summer months although some reproduction and attachment was noted throughout the year.

Two species of amphipods, *Erichthonius disjunctus* Stout[3] and *Lembos concavus* Stout[3] which construct tubular compartments of organic secretion and silt for concealment, were conspicuous members of the sedentary associations, the tubes being attached directly to the panels or to colonies of *Bugula.* During sporadic outbursts of these forms, usually in the winter, the amphipod tubes were especially noticeable. Because of the small size of the tubes, 10 to 15 mm. long, they may be considered of minor importance as fouling organisms.

Sponges are widely distributed in Kaneohe Bay and are abundant bottom dwellers in the vicinity of our field experiments. As few simple or colonial forms became attached to floating or submerged panels during the course of our work, no further consideration is given the group in this report.

Especially during the spring and summer months hydroids were important constituents of fouling associations. Numerous undetermined species, mostly Campanularidae, with colonies usually under 30 mm. high, were common on surface floats from March to August, and occasionally well developed colonies were observed during the winter. Rapidly growing colonies of *Pennaria,* probably *Pennaria tiarella* McCrady, appeared at irregular intervals, being especially prolific during August and September 1937. The species, which is abundant in Kaneohe Bay, developed best on deeply submerged panels rather than floating ones. During 3 years, but one coral colony was observed attached to test panels. It developed on a glass plate in March 1938.

Colonial forms of Infusoria attached to other sessile animals or plants were frequently observed. Alone these colonies of Protozoa are of little consequence as fouling organisms but may add somewhat to the friction of *Bugula,* to the stems and branches of which they often thickly adhere.

In Kaneohe Bay filamentous algae may compete with animals as major fouling organisms, especially in locations with light intensity most favorable to the growth of the plants. In the experimental area algae accumulated more abundantly on floating panels or near the

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[3] Specific determinations by Clarence R. Shoemaker of the United States National Museum, Washington, D. C.

upper borders of those completely submerged. Test panels suspended from the side of the pier receiving a maximum of sunlight were soon heavily fouled by the plants, while those a few feet away but in a more shaded position gathered little or no algae. Rapid fouling of panels by algae occurred in the Pearl Harbor area often to the exclusion of animal sedentary forms.

Besides the numerous organisms which become fixed to submerged structures many others, because of their more or less permanent biological associations or because of temporary concealment, may be recognized as a part of the fouling complex. Among crustaceans which find favorable habitats under such conditions are free-living amphipods including caprellids which are parasitic on hydroids and *Bugula*. Many species of crabs, the most common in the areas observed being *Pilumnus oahuensis* Edmondson, find a harbor among the fixed organisms. Swimming crabs of the family Portunidae frequently find a temporary resting place on submerged panels. Numerous isopods, including *Limnoria* which is destructive of submerged wood, were almost always associated with test panels.

Various free-living mollusks commonly frequent habitats offered by masses of sessile organisms. In the Kaneohe Bay area the most common forms of gastropods taken from panels include *Peristerina chlorostoma* Sowerby, *Crepidula aculeata* Gmelin, *Triforis incisus* Pease, *Melanella aciculata* Pease, *Littorina scabra* Linnaeus, and *Atys semistriata* Pease. Nudibranchs also frequently occurred. A member of the family Mytilidae, *Musculus oahuus* Bartsch, was common in this locality, being attached to or buried in the tunics of ascidians. Its relationship seems to be that of a commensal. The bivalve mollusk, *Teredo parksi* Bartsch, which is the common "ship worm" destructive of wood structures in Kaneohe Bay and Pearl Harbor, constantly infested test panels except those of metal and glass during the course of our investigations. Observations on the natural history and destructiveness of this mollusk in Hawaii will be made in a separate report.

Barnacles

In Kaneohe Bay, the barnacles which become attached to floats and submerged panels are representatives of two genera. The most abundant form is a variety of *Balanus amphitrite*, probably *B. amphitrite* forma *hawaiiensis* Broch. Typically the outer plates of the shell

of this barnacle are marked by narrow reddish or brownish vertical stripes (pl. 1, *A, B*). At least two other apparent varieties of *B. amphitrite* are numerous in Pearl Harbor but less common in Kaneohe Bay. One grows tall and narrow with a slightly curved beak and the other is more like the typical form of the species but has a white shell. These, however, may be but local growth and color variations.

The genus *Chelonibia* is represented on our test panels by an occasional specimen of *C. testudinaria* (Linnaeus). This species has a low, flat shell with a large aperture and small opercular plates. As a fouling organism it may be considered negligible. In the following discussion, reference to barnacles will signify *Balanus amphitrite*, unless otherwise stated.

Barnacles become readily attached to almost any submerged surface and make rapid growth if conditions are favorable. The normal rate is about 15 mm. in diameter of base in 40 to 60 days, at which time maturity is attained and spawning occurs. An exceptionally rapid growth took place during the fall of 1935 when some barnacles reached a diameter of 15 mm. in 28 days. Spawning has occasionally been observed in individuals with shells but 12 mm. in diameter. At the time of attachment the shell of the young barnacle is 0.5 mm. or less across; growth is rapid during the first two or three weeks then slows to a more gradual increase up to a diameter of about 25 mm. which is attained within the first year (table 1). This is apparently near the maximum size reached by the species, as adult specimens attached to piling near the station vary from 22 to 26 mm. in diameter after a growth of 3 years. Overcrowded individuals are smaller in diameter but taller. Light intensity, food supply, temperature of the water, etc., influence the growth of barnacles.

Table 1. Rate of growth of Balanus amphitrite on unpainted surfaces

Days	Diameter in mm.	Periods of Growth
1	0.5	Aug. 8-9, 1936
6	2	June 17-23, 1937
14	8	Oct. 4-18, 1935
18	10	Nov. 18-Dec. 6, 1936
28	15	Oct. 4-Nov. 1, 1935
73	17	April 16-June 28, 1935
126	18	March 20-July 24, 1935
342	24	Oct. 21, 1935-Sept. 27, 1936

The smaller size reached by barnacles in a given period on toxic surfaces is probably due to delayed attachment rather than to a slower growth rate after affixation (table 2).

Table 2. Rate of growth of Balanus amphitrite on surfaces coated with toxic paints

DAYS	DIAMETER IN MM.	NATURE OF COATING
54	3	Yacht Green
54	3	Antifouling Germicide
106	12	Copper Red
151	8	Marine Green
164	12	Federal Antifouling
177	17	Cape Cod
383	18	Antifouling Composition

It is a common observation that the under surface of a panel floating horizontally on the surface or just beneath it will collect large numbers of barnacles while the upper surface, although washed by water, may be entirely free of them. That phototropic responses may be concerned with the settling and attachment of many sedentary organisms, including barnacles, is a generally accepted view.

While it is clearly demonstrated that the nauplius stage of the barnacle larva exhibits positive phototropism, Visscher (33) points out that at the time of fixation the cyprids of some barnacles show negative phototropism and are attracted toward the shade rather than toward the light. Although the observations of Herz (16) on the cyprids of *Balanus crenatus* are contrary to this view, it is generally supported by experimental evidence. Unshaded panels suspended vertically in the water usually are about equally fouled by barnacles on both surfaces if they are non-toxic and of similar color. However, if one surface is shaded more than the other the shaded one accumulates more barnacles. Areas contrasted by coats of black and white non-toxic enamels clearly illustrate the relative attraction of light and shade to the cyprid stage of the barnacle. After 57 days a black coated panel supported 772 barnacles, while a white one of similar size supported but 93. Our experiments verify the observations of others that white surfaces are, for a short period of time, less heavily fouled by most sedentary organisms than are dark surfaces (pl. 4, *A*). This is generally true regardless of the composition of the supporting material, provided it be non-toxic.

Although barnacles cause fouling throughout the year in Kaneohe Bay, there are periods when attachment reaches high and low levels. During two weeks beginning November 23, 1937, the number of barnacles affixed to a panel 48 square inches in area was 288 times the number attached to a similar panel during the first two weeks of November of the same year. During the winter months fouling is considerably reduced but not completely inhibited. Fewer barnacles become attached and their growth is slower at this time. Between January and March the surface waters reach a minimum temperature for the year, usually between 20°C. and 21°C., and periods of turbidity and dilution are frequent owing to heavy rains. Less fouling by barnacles during these months is probably due to unfavorable conditions for metamorphosis and attachment. Examination of adult specimens during this period of suppression indicates an abundance of nauplii in the process of development, but relatively few cyprids become affixed. That the growth of barnacles is retarded by one half or more during the winter season is shown by such typical records as 3 mm. in diameter from February 8 to March 2, (22 days), and 6 mm. in diameter from January 26 to March 2, (35 days). (For normal growth during favorable seasons, see table 1.)

Since it is evident that the behavior of barnacles, during both larval and adult stages, is affected by the physical and chemical factors of the environment, a series of laboratory experiments was conducted with nauplii and adults to determine their responses and resistance to changes of temperature, salinity, desiccation, pH, etc.

When active nauplii are suddenly exposed to fresh water they immediately cease to swim and fall to the bottom where slight activity of appendages may be observed for about 5 minutes. On return to normal sea water they resume activity in from 1 to 5 minutes. If the exposure to fresh water is as long as 10 minutes it may require from 25 to 30 minutes for a renewal of activity after the organisms are returned to sea water. After about 1 hour most of the nauplii swim freely. No recovery was observed among nauplii following their exposure to fresh water for periods of 12 to 15 minutes.

When nauplii are suddenly transferred to a mixture of 3 parts of sea water to 1 part of fresh water they exhibit no immediate cessation of movement and the phototropic response remains normal. After 20 hours in this dilution they all swim freely and at the end of 46 hours many are still swimming and all show activity. Nauplii exposed to

equal parts of sea water and fresh water exhibit temporary shock, falling to the bottom and swimming about erratically without normal phototropic response. In 10 minutes specimens regain ability to swim and to respond phototropically. After 20 hours nearly all swim and all are active. In 46 hours some still swim and nearly all are active. On placing nauplii in a solution of 1 part sea water and 3 parts fresh water they cease swimming at once and sink to the bottom where feeble movements of appendages are observed. After 10 minutes many have regained the power to swim and within 1 hour nearly all show this activity. Serious injury to the nauplii, however, is evident within 20 hours when most of them have become too weak to swim. After 46 hours a few specimens swim feebly and slight activity of appendages is detected in others. This degree of dilution of sea water is obviously near the limit of endurance of nauplii even for a period of a few hours.

The resistance of barnacles of various sizes and ages to fresh water and to diluted sea water was also determined. One hundred specimens, ranging in diameter of base from less than 1 mm. to 4 mm., the larger ones being from 18 to 20 days old, and all attached close together, were subjected to circulating fresh water. In 24 hours 5 percent of the specimens were dead and in 48 hours 55 percent were dead. At the end of 72 hours 23 percent were still alive, but in 96 hours only 3 of the original specimens had survived. In this group of young barnacles the rapidity of the lethal effect of fresh water had little correlation with age or size. Some of the larger specimens were killed as quickly as some of the smaller ones. Mature barnacles, from 18 to 22 mm. in diameter and from 6 to 12 months old, show a greater resistance to fresh water than do those less than a month old. Some of the adult barnacles tested endured circulating fresh water for a period of 9 days but none survived for 10 days. Visscher (32) reported that specimens of *Balanus amphitrite* were killed by fresh water in 24 hours.

In a solution of 3 parts of sea water to 1 part fresh water adult specimens about 20 mm. in diameter were able to live for at least 58 days, while young specimens up to 8 mm. in diameter lived for at least 53 days. Young and adult specimens lived about equally long in sea water diluted by equal parts of fresh water, and both survived in this solution nearly as long as they did in a solution of 3 parts of sea water. In all dilution tests the animals remained in standing

water which was changed daily. Some species of barnacle have become adapted to very dilute sea water. Cowles (12) cites *Balanus eburneus* as typical of brackish water and mentions an undetermined species of the Atlantic coast which flourishes in practically fresh water.

Rapid reduction of the temperature of water containing barnacle nauplii from normal, 25°C., to 0°C. in 32 minutes resulted in no permanent injury to the organisms. Most of the specimens ceased swimming at 13°C. and all were on the bottom at 10°C. Slight activity was still observed in many at 3°C. but all movements ceased at 0°C. The temperature was then reversed and gradually returned to normal. At 6°C. slight activity of the appendages was resumed by the nauplii, and at 17°C. about 50 percent of the specimens began to swim freely. At 20°C. nearly all were swimming with normal phototropic response.

When the temperature of a cooling chamber was rapidly reduced from normal, 26.5°C., to 9.5°C. and maintained at this degree for 1 hour, all specimens ceased swimming but some slight activity of appendages was still observed. Twenty-four hours later with the temperature at 8.5°C. a few nauplii exhibited slight activity and nearly all resumed movements at once when restored to sea water of normal temperature. With the temperature at 8.5°C. for 84 hours a few nauplii still exhibited slight activity of appendages, but after 108 hours no movements were detected. Returned to normal temperature, not more than 10 percent of the specimens showed the slightest activity and none fully recovered. On reducing the temperature from normal to 7°C. slight activity was observed among nauplii after 64 hours. After 84 hours no movement occurred and only about 10 percent recovered on return to normal sea water. No recovery took place after nauplii had been subjected to 7°C. for a period of 108 hours. Nauplii, however, are capable of enduring temperatures much lower than 7°C. for extended periods of time. Water containing active specimens was reduced from normal temperature to -1°C. during 2 hours. Though some individuals survived this low constant temperature for 24 hours, they were near their limit of endurance.

Both young and adult barnacles show considerable resistance to low temperatures. Young specimens with diameters up to 8 mm., are little affected in water at 2°C. for 48 hours, and approximately 25 percent live at this temperature for at least 68 hours. Some smaller individuals, 2 mm. in diameter, are as resistant as many larger ones.

Adult barnacles, averaging 20 mm. in diameter, have lived 72 hours in water at -1°C., with part of the water at this temperature converted into ice, but none of those examined survived this low degree for 96 hours.

In rapidly rising temperature, beginning at 26°C., all nauplii were rendered inactive by the time 41°C. was reached. When restored to normal temperature some regained activity in 15 minutes and within 1 hour 90 percent of them had recovered sufficiently to resume swimming. Under constant temperature, nauplii endured 35°C. for 24 hours at the end of which period about 50 percent of them were still swimming and nearly all were active. After 42 hours at this temperature a few nauplii swam feebly and many exhibited activity of appendages. None, however, survived 60 hours at 35°C.

Adult barnacles submerged in water with the temperature fluctuating between 34°C. and 35°C. survived for 72 hours but did not revive after 86 hours. Numerous tests indicate that young barnacles, up to 8 mm. in diameter, are somewhat more resistant to high constant temperature than are adults.

The resistance of barnacles to desiccation when exposed to the air depends upon the physical condition of the surrounding atmosphere which determines the rapidity at which evaporation takes place. Out of water and in shade, under normal temperature of the laboratory varying between 22°C. and 26°C., adult barnacles lived for 27 days but not for 33 days. Out of water and exposed to the direct rays of the sun, with the air temperature ranging from 30°C. to 35°C., adults lived from 3 to 5 hours. In tests with the air temperature at 45°C. barnacles showed evidences of life after 4 hours but did not recover when returned to normal sea water. Cole (11) states that *Balanus tintinabulum* survived for 12 days out of water in a temperature that at times exceeded 50°C. Evidently this record was taken in alternating shade and sunlight.

Laboratory determinations of the resistance of nauplii to reduced hydrogen ion concentration of sea water were made. On lowering the pH from 8.6 to 7.2, without alteration for salt content, nauplii maintained normal activity for about 22 hours. On a reduction to pH 6 many nauplii ceased swimming in 4 or 5 hours, and after 7 hours activity was observed only in slight movements of appendages.

Transferring marine craft to fresh water when heavily fouled by barnacles has frequently been suggested and put into practice in an

attempt to rid the hulls of the organisms. From the foregoing results, it is evident that, with the capacity to endure fresh water which adult barnacles exhibit, it would require considerable time for their destruction. Since only the soft parts and the opercular valves are washed away when the animal dies, scraping the surface would still be essential. The basal and wall plates of the shells would remain firmly attached, for some time at least, and would create almost as much friction in the water as living organisms.

BRYOZOA

Members of the group Bryozoa (Polyzoa) are among the most common fouling organisms in Kaneohe Bay. Both upright colonies and encrusting forms are well represented. The tuftlike species, *Bugula neritina,* is especially abundant throughout most of the year. In local waters this widely distributed form may attain a height of about 3 inches in 3 months which is a usual size for full-grown colonies. (See plate 1, *D* and table 3.) The rapid growth of this species during the periods of its greatest development makes it a formidable fouling organism. Reproductive ooecia usually appear on colonies after reaching a height of about 25 mm., which is accomplished in about 2 weeks. The species readily becomes attached to almost any non-toxic surface; even toxic paints frequently show little efficiency in repelling it.

Table 3. Rate of growth of Bugula neritina on unpainted surfaces

DAYS	HEIGHT IN MM.	PERIODS OF GROWTH
½	0.25	Aug. 9, 1936 (night)
2	1	Aug. 6-8, 1936
4	2	Aug 8-12, 1936
9	4	July 28-Aug. 6, 1936
14	25	Oct. 18-Nov. 1, 1935
19	40	July 25-Aug. 13, 1936
28	50	April 7-May 5, 1935
50	60	Nov. 1-Dec. 20, 1935
87	70	Nov. 18, 1935-Feb. 13, 1936
127	63	May 2-Sept. 6, 1936
156	65	Mar. 3-Aug. 6, 1936

Observations on the early phases of *Bugula* after affixation indicate that within a few hours after the free-swimming larva has settled the young colony has extended itself above the point of attachment, thus the fast-growing parts are beyond the influence of whatever toxic elements there may have been on the surface. The largest colony observed during our experiments developed on a toxic surface to a height of 100 mm. in 100 days. Monthly records for 3 years show that *Bugula* appears in local waters during all seasons but is less abundant during the winter months, probably due to physical conditions previously mentioned (p. 260). Miyazaki (23) observed that *B. neritina,* in Kanagawa Prefecture, Japan, settled when the temperature of the water remained above 20°C. In successive years our test panels in Kaneohe Bay were lightly infested by *Bugula* during the months of January and February. Its rate of growth was slow—15 mm. from January 28 to February 28. A prolific development, usually begins in March and lasts throughout the rest of the year. Grave (15) states that *B. flabellata* reaches old age in 3 months in the Woods Hole region. Seldom does *B. neritina* live longer than 3 months in Kaneohe Bay.

On toxic surfaces *Bugula* usually shows a more restricted growth in a given period than on an untreated surface (tables 3 and 4). This is probably due to delayed attachment rather than to a slower rate of growth after settling.

Table 4. Rate of growth of Bugula neritina on surfaces coated with toxic paints

Days	Height in mm.	Nature of coating
106	30	Copper Red
140	40	Marine Green
140	35	Federal Antifouling
146	50	Yacht Green
188	30	Cape Cod
188	50	creosote
188	50	varnished over toxic paint

An undetermined species of *Amathia,* developing a soft, flexible colony with zooecia spirally arranged about the stem and branches is occasionally taken on test panels in Kaneohe Bay, and also occurs on the bottom of boats anchored for some time in Pearl Harbor. This

form lacks the rigidity of *Bugula* and appears in recumbent masses. Because of its soft consistency *Amathia* is not of major importance as a fouling organism. Even if the species became attached to a boat at rest and developed into a mature colony it would likely be torn to pieces if the craft were moved.

Another branched colony of soft consistency, *Zobotryon pellucidus* Ehrenberg, was taken but once from test panels in Kaneohe Bay, the colony reaching a height of 50 mm. in 56 days. It also has been taken, occasionally, from the bottoms of boats in Pearl Harbor. Like *Amathia* the translucent colony becomes recumbent with age and, because of its infrequent occurrence, may be considered of minor importance as a fouling organism in local waters. Minute species spreading over surfaces by means of stolons are not uncommon. Two of these, *Aetea truncata* (Landsborough) and *Catenaria lafonti* (Audouin), readily attach to wood, metal or glass panels. They are negligible as fouling organisms, however, since their sparse vertical growths usually amount to but 2 or 3 mm.

Encrusting forms of bryozoans are among the most common sedentary organisms in the area of Kaneohe Bay under observation. Because of the rapid spread of colonies and their habit of overgrowing other sessile forms, they greatly increase the thickness and roughness of the fouling association. Two species in local waters have been tentatively identified as *Rhynchozoon nudum* Canu and Bassler and *Schizoporella unicornis* (Johnston). The latter is especially abundant, reproducing throughout the year (pl. 1, *C.*). Early stages may be taken by suspending a panel in the water for but a few hours. In 6 days colonies 2 mm. in diameter with 10 zooecia commonly appear. In 12 days colonies may reach a diameter of 3 mm. and have 16 zooecia. Increase in diameter and number of zooecia now progresses rapidly. An average growth of 1 mm. per day in diameter of colony is not unusual for the first month, after which development is less rapid (table 5). Test panels 12 inches square are often completely coated with crowded colonies of *Schizoporella,* each 50 to 70 mm. in diameter, within a period of 3 months.

An analysis of the rate of growth of this species on surfaces treated with toxic paints suggests that some of the coatings are efficient in delaying the attachment of the organism for some time

Table 5. Rate of growth of colonies of Schizoporella unicornis ? on unpainted surfaces

Days	Diameter in mm.	Periods of growth
6	2	June 17-23, 1937
14	15	Oct. 4-18, 1936
28	25	Dec. 6, 1936-Jan. 3, 1937
34	33	Nov. 1-Dec. 4, 1936
46	45	Nov. 18, 1935-Jan. 3, 1936
69	50	Mar. 20-May 28, 1935
85	62	Mar. 20-June 13, 1935
100	70	Mar. 20-June 28, 1935
132	60	Nov. 28, 1936-April 9, 1937

while others apparently have little influence on attachment (table 6). Like most other sedentary forms observed, *Schizoporella* becomes attached to a dark surface more readily than to a light one, if both be non-toxic. Enameled metal plates, suspended vertically, collected many more colonies on the black surface than on the white one of the same plate. Any panels with dark and light surfaces, both non-toxic, show a similar contrast in number of encrusting bryozoans attached.

Table 6. Rate of growth of colonies of Schizoporella unicornis ? on surfaces coated with toxic paints

Days	Diameter in mm.	Nature of coating
32	30	creosote
46	40	Kress white enamel (copper oleate added)
100	40	Antifouling Composition
100	28	Kress white enamel (mercuric chloride added)
112	40	Yacht Green
432	35	Copper Red

Catches of bryozoans at different periods of the year indicate that *Bugula* becomes affixed as readily during the night as during the day. Observations under natural conditions were verified by laboratory experiments in which larvae of *Bugula* settled on floating panels in the dark as well as in the light. However, *Schizoporella* became attached more readily in the dark and on floating panels rather than on those deeply submerged.

Because of the character of the organisms it is difficult to determine with accuracy the degree of resistance of bryozoans to such ecological factors as dilute sea water, temperature, desiccation, etc. Few experiments of this nature were made with local forms. Tests with colonies of *Bugula neritina* indicate that this species dies in fresh water within 30 minutes.

SERPULID WORMS

In Kaneohe Bay serpulid worms find attachment on test panels throughout the year, although they are more abundant at irregular intervals. Their coiled and twisted tubes interspersed among other sedentary organisms materially increase the friction of a surface moving through the water. The most prevalent species in Kaneohe Bay and Pearl Harbor is the widely distributed form, *Hydroides norvegica,* although *H. lunulifera* is also abundant. On reaching a length of about 25 mm., the tube of *H. norvegica* often develops two longitudinal ridges on the upper surface (pl. 2, *B*). If the ridges are indistinct, the tube of the species can usually be distinguished from that of *H. lunulifera* by its thinner wall. *H. lunulifera* has a thick walled tube which attains greater diameter and length than that of *H. norvegica.* No longitudinal ridges mark the tube of *H. lunulifera* but with maturity it becomes roughened by circular lines and costae (pl. 2, *A*).

Table 7. Rate of growth of serpulid worm tubes on unpainted surfaces

DAYS	LENGTH IN MM.	PERIODS OF GROWTH
½	3	night of Aug. 24, 1936
6	6	June 11-17, 1937
15	24	July 25-Aug. 9, 1936
30	30	July 10-Aug. 9, 1936
58	32	April 16-June 13, 1935
86	55	April 3-June 28, 1935
104	60	Nov. 28, 1936-April 9, 1937
192	50	April 7-Oct. 16, 1936
322	106[4]	April 7, 1936-Feb. 23, 1937

The cleavage stages, the trochophore, and the early larval phases of *H. norvegica* were observed. A wormlike form with rudimentary

[4] Tube of *Hydroides lunulifera.* Other data in table refer to *H. norvegica.*

branchiae developed in 8 days. This phase doubtless is almost immediately followed by affixation and secretion of a tube, phenomena which were not observed. After attachment of the young worm the secretion of the tube proceeds rapidly. During one night, a period of 11 hours, tubes 3 mm. long developed on wooden panels submerged near the bottom, while tubes 1 mm. long were formed on floating glass panels. In the first month serpulid worm tubes increase in length at an average of about 1 mm. per day after which the rate is reduced. Under favorable conditions in Kaneohe Bay tubes of *H. norvegica* attain a length of 50 to 60 mm. in 3 or 4 months. This is approximately full growth for the species in this locality (table 7). Tubes of *H. lunulifera* 75 mm. long are not uncommon. The largest one observed during our experiments attained a length of 106 mm. in 322 days (table 7). Other species of serpulid worms rarely attached to test panels in this area, although sporadic development of *Salmacina dysteri* occurred, the heaviest growth taking place during the summer and fall months. (See p. 255 and pl. 2, *C*.) The influence of toxic surfaces on the rate of development of serpulid worms was not determined, but antifouling coatings obviously delayed their attachment (table 8).

Table 8. Rate of growth of serpulid worm tubes on surfaces coated with toxic paints

Days	Length in mm.	Nature of coating
99	32	Yacht Green
115	20	Antifouling Composition
151	40	Copper Red
151	30	Marine green
190	40	Antifouling Germicide
376	80[4]	Yacht Green
376	70[4]	Yacht Bottom Enamel
412	50[4]	Copper Red

Our experiments indicated that larvae of serpulid worms prefer to settle on dark surfaces rather than light, although the evidence was not wholly conclusive. Three panels of equal area (27 square inches), one unpainted and two coated with non-toxic enamels, one black and the other white, were submerged in sea water for 8 days. Twenty-

[4] Tubes of *Hydroides lunulifera*. Other data in table refer to *H. norvegica*.

two worms attached to the unpainted surface, 17 to the white area and 100 to the black one. At another time of the year tests with glass panels over a 14 day period indicated that little discrimination was shown by serpulid worms in their attachment to white and blue plates. Large numbers of worms have been known to settle quickly on highly toxic surfaces to the exclusion of other organisms.

Some larvae of serpulid worms and other fouling organisms doubtless possess a high degree of resistance, which enables them to become attached under conditions that would be unfavorable to others. It is suggested that the settling process for all sedimentary forms is indicative of a certain physiological state of the organism and that if this condition does not persist when contact is made with a surface the chances of affixation are slight.

Day and night catches at different times of the year showed that serpulid worms settle during daylight and night with no apparent preference. There is a difference, however, in the number of serpulid worms attached at different levels in the water. While floating panels collect serpulid worm tubes, those suspended low in the water or resting on the bottom usually attract more. Two panels, each having an area of 74 square inches, including both sides, were suspended vertically in the water, the upper border of one 18 inches below the lower border of the other. After exposure for 8 days, 65 worm tubes were attached to the lower panel and 3 to the upper one. Serpulid worms enclosed in their tubes are little injured by prolonged contact with silt-laden water and will endure complete submergence in sand and mud for a considerable period. Since the tubes of serpulid worms are usually found on the under surfaces of stones in their natural shoal water habitat, it is possible that a negative phototropic response explains their preference for lower levels in the water.

That serpulid worms may, at times, constitute the primary fouling organisms in local waters is shown by examination of the hulls of United States Navy craft drydocked at Pearl Harbor. On January 24, 1938, the hull of the submarine *Argonaut* was encrusted with masses of serpulid worms, which chiefly composed the fouling and represented a growth of about 10 months in Pearl Harbor. Heavy fouling, observed on the bottoms of destroyers drydocked in Pearl Harbor on February 23, 1938, consisted mainly of *H. norvegica,* some tubes of which were 55 mm. long. The growth was remarkable, as it represented but 6 weeks of winter fouling. As the tubes of serpulid

worms become longer, they tend to rise from the surface of attachment and stand out at a sharp angle from the initial portion. The living animal is thus carried away from toxicants of the coating and is assured more complete aëration.

Laboratory experiments determined the resistance of serpulid worms to fresh water and diluted sea water. When exposed to fresh water adults of *H. norvegica,* in their tubes, usually died in 4 hours. In a mixture of one part of sea water to three parts of fresh water they showed slight response to mechanical stimuli after 9 hours, but all died within 24 hours. In sea water diluted by equal parts of fresh water some lived more than 27 hours, but none for 48 hours. In 3 parts of sea water to 1 part of fresh water, specimens have lived more than 50 days. Fresh water or diluted sea water slightly expands the anterior part of the serpulid worm, causing the branchiae and operculum to be extended from the tube. This results in a more rapid lethal effect on the anterior extremity, the branchiae losing the capacity to respond to stimuli while the posterior portion of the body enclosed in the tube is still active. Pearse (30) observed the ability of numerous marine annelids to endure a mixture of three fourths sea water to one fourth fresh water for a week or two, and concluded that delicate forms lived almost as long as tough ones.

Mollusks

A smooth, thin-shelled oyster, *Ostrea thaanumi* (p. 255; pl. 3, *A*), is the most constant molluscan member of the fouling complex in the Kaneohe Bay area. Heavy infestations of panels usually occur from March to November with a minimum of reproduction and growth during the winter months. Larval forms of the oyster, however, may be taken by towing during all months of the year. Like serpulid worms, *Ostrea* finds most favorable conditions for attachment in the lower levels of the water. Horizontally placed panels with one face directed upward and the other downward collect more oysters on the lower surface. During 10 days in October, 1937, the lower surface of a wood panel 180 square mm. in area and suspended near the bottom collected more than 500 young oysters while less than one tenth of that number became affixed to a similar panel one foot higher in the water. Nelson (26) observed that the larvae of oysters exhibited a strong positive stereotropism just before attachment and with materials at the bottom to serve as cultch the organisms became

affixed in that position. Hopkins (18) found that 100 times more larvae of *Ostrea lurida* attached to the under side of a horizontal surface than to a vertical one. He suggests that it is not because of a phototropic response but because the larva swims with its foot directed upward and naturally comes in contact with the lower surface of a support.

At the time of attachment the shell of *O. thaanumi* is about 0.5 mm. in diameter and in 6 days thereafter measures 2 mm. Under favorable conditions it reaches a diameter of 25 mm. in 3 months, after which it grows more slowly. The largest specimen we observed developed a shell 50 mm. across in 322 days. This is probably near the maximum size reached by the species (table 9).

The rate of growth of isolated specimens of the small pearl oyster, *Pinctada nebulosa* (p. 255), is approximate only. Shells 15 mm. across have developed within 49 days and specimens 30 mm. long have reached that size in 105 days. After 414 days, test panels have carried shells 43 mm. across. It may be assumed that the oyster is younger than the exposed period of the panel.

Although the bivalve mollusks, *Ostrea sandvichensis* Sowerby and *Anomia nobilis* Reeve, have not appeared on test panels in Kaneohe Bay, both have, at times, accumulated in great quantity on the bottoms

Table 9. Rate of growth of Ostrea thaanumi on unpainted surfaces

Days	Long diameter in mm.	Periods of growth
6	2	June 17-23, 1937
24	5	July 1-25, 1936
39	10	July 1-Aug. 9, 1936
45	14	July 1-Aug. 15, 1936
65	23	June 19-Aug. 23, 1936
77	25	July 18-Oct. 3, 1936
100	28	March 20-June 28, 1935
174	35	March 3-Aug. 23, 1936
322	50	April 7, 1936-Feb. 23, 1937

of naval craft in Pearl Harbor. On June 1, 1936, the decommissioned U.S.S. *Chicago* was placed in dry dock in Honolulu, after having been at rest in Pearl Harbor for 5 years. The hull was densely covered to a depth of several inches with masses of *O. sandvichensis* almost to the exclusion of other organisms. Following an anchorage in

Pearl Harbor of approximately 3 months (early May to early August, 1937), the hull of the U.S.S. *Chester,* when docked, was found to be heavily fouled by the bivalve mollusk, *Anomia nobilis,* and a coating of serpulid worms, while barnacles were almost negligible.

Few investigations were made to determine the resistance of mollusks to altered environment. On exposure to fresh water young individuals of *O. thaanumi,* 8 mm. in diameter, live for 2 or 3 days, while halfgrown specimens of *Pinctada nebulosa* usually die within 2 days.

EFFECT OF METALS ON FOULING

Sheathing the hulls of wooden craft with copper to prevent fouling was once considered economical, but became generally impractical with iron ships because of the electrolysis which was set up when the two metals came in contact. Numerous investigators who have tested the relative capacity of various metals to repel sedentary organisms agree that copper is quite effective and that other metals with high alloys of copper or other soluble toxins also show this ability. Why some metals have this property to a greater extent than others is explained by Parker (29), who points out that because of their high solubility the ions of copper and zinc develop a poisonous layer next these metals preventing organisms from growing on them. Metals like iron, lead, tin and aluminum have relatively insoluble ions and therefore foul quickly.

In our experiments in Kaneohe Bay, we used iron, tin, galvanized iron, lead, monel, German silver, brass, copper, and zinc panels. They were used separately or coupled together in various combinations. In general, copper and its alloys, brass and German silver were more effective in preventing fouling than other metals. Zinc usually came next in order of merit. Over a period of 13 days, results for 7 metal panels were as follows: iron, tin, lead, and galvanized iron were fouled by barnacles in a descending degree, while copper, brass, and zinc were free of organisms. After 26 days no organisms had settled on copper, brass, or German silver although the other 6 metals used were more or less fouled. Similar results followed tests extending over 43 and 57 day periods. Comparing copper, zinc, tin, and iron over a period of approximately 3 months, copper was found to be fouled only by fine filamentous algae, while the other metals were well covered by barnacles; zinc, however, supported fewer than tin

or iron. German silver, consisting of approximately 50 percent copper, 25 percent zinc and 25 percent nickel, frequently was fouled by algae within 40 days, but was quite effective in preventing the attachment of other sedentary organisms over periods of about 3 months, as were brass and copper. Visscher (32) observed that copper was a good repellent of hydroids and algae but not so effective with respect to barnacles, serpulid worms, and bryozoans. Orton (28) found that copper successfully prevented fouling for 14.5 months and that few organisms were attached to zinc during periods of slightly more than 3 months. Gardner (14) quotes the observation of Young that English ships with copper bottoms usually were fouled in 10 months.

Copper and brass panels which are relatively effective in preventing fouling apparently lose this efficiency if removed from the water for a short time, then used again. Copper plates free from organisms after one month in the sea were removed and exposed to the air for 30 days after which they were replaced in the water. Twenty-six days later they were found to be heavily fouled by serpulid worms, *Bugula,* and a few barnacles. The size of the organisms indicated that attachments took place immediately following resubmergence of the panels.

When iron or tin is brought into close contact with copper the copper loses its capacity to repel sedentary organisms and fouls quickly. Parker (29) has shown that if two metals in the electromotive series are in contact, erosion is restricted to the one occupying a superior position in the series. Since iron and tin are on higher planes than copper the latter is incapable of releasing toxic substances and therefore permits the organisms to settle and become attached. Our results were in accord with those of Parker. When iron or tin plates were riveted closely to copper or brass the last two attracted barnacles quite as readily as did the metals with which they were coupled (pl. 4, *B*). Copper plates placed in juxtaposition with iron or tin were found to foul if the interval between the plates was reduced to 20 mm. or less.

THE EFFECT OF PAINTS ON FOULING

With the advent of ocean-going ships with metal hulls about the middle of the nineteenth century, stress began to be placed upon the application of specially prepared paints to surfaces exposed to sea water. The two objectives were, first, the preservation of the metal

bottom from corrosive action of the water, and second, the prevention of attachment and development of fouling organisms. Fouling became as important in the economy of ocean traffic as corrosion. In Europe, attention was soon drawn to the loss of time, increased fuel consumption, and repairs necessitated by the rapid growth of organic material on the hulls of marine craft. Early steam-driven iron ships in commerce between England and China frequently lost 2 or 3 months each trip because of fouling, and some became unmanageable and useless after 12 months. Gardner (14) quotes Young as reporting that the Peninsular and Oriental Steamship Line spent £70,000 annually to keep its ships in good condition. Ships of war were likewise affected and were known to lose a mile per hour in speed after 6 to 8 weeks and sometimes were pronounced useless in a few months. Such antifouling paints as were then available apparently proved of little value.

Previous to 1902 the United States Navy used various commercial paints on the hulls of its vessels, each type of craft requiring a different kind of paint. The necessity of keeping large stocks of many kinds of paints at the several navy yards finally became so impracticable that the Navy began to standardize and manufacture its own ship-bottom paints. Following a long series of experiments two types of paints were adopted: one was anticorrosive in function, the other antifouling. The anticorrosive coating was applied directly to the metal bottom and covered by the antifouling composition. This method is still practiced, although several different formulae of antifouling paints, of both foreign and American sources, are now used by the navy.

It is obvious that the best of antifouling compositions are but temporary repellents of sedentary organisms. Conditions other than the nature of the paint must be considered in determining the rapidity of fouling. The reproductive periods of the organisms which vary with latitudes, the temperature of the water through which the boat passes, the speed at which it travels, the length of time at anchorage in harbors, and the location of anchorages are important factors. A report in the American Bureau of Shipping Bulletin for March-April 1924 indicates that while Atlantic Ocean fast passenger ships maintain their speed for 6 or 8 months after being dry-docked, cargo vessels show reduced speed in half that time. The Shipping Board steamer *Hog Island* on the third voyage, after release from dry dock,

from the Atlantic coast of the United States to the Mediterranean Sea, lost speed to the extent of 18 percent and fuel consumption increased 29 percent. The boat was painted with Norfolk Navy standard paint.

Neu (27), after experimenting in the North Sea, concluded that antifouling paints may delay the settling of larvae for a time but that the toxic elements have no effect on the growth of the organisms after attachment. Neu graded the antifouling compositions, in Germany, for use in different parts of the world. Those designated by him as B, C and D are increasingly poisonous. Paint D is used on ships going into the tropics, paint C on ships in temperate waters, and paint B on ships in colder waters. However, experiments showed that paint D was as heavily fouled, after a given period, as paint B. Fishermen of the North Sea apply the least poisonous paints to their boats, since they cost less and prove to be about as efficient antifoulers as the more toxic and expensive ones.

Although the method of exfoliation, the use of a paint that will wear away with the attached organisms, has been suggested from time to time as a substitute for antifouling coatings, it has received no serious consideration. A chief objection to exfoliation is that erosion of the surface paint does not take place at the same rate in harbors and at sea. Passing from warmer into cooler water or vice versa also has a variable effect on erosion. If exfoliation proceeds rapidly the frequent repainting becomes an economic factor not to be disregarded. Eroding paint does not always carry away with it the sedentary organisms attached to the surface. Frequently cyprids of barnacles bore their way through the paint covering a panel and become fixed to the solid surface. As the young barnacles grow and their plates expand they push up the layer of paint. The tests of adult barnacles may thus acquire external coatings of the paint applied to the surface. Even coatings assumed to be highly toxic are sometimes burrowed through by cyprids, apparently without ill effect. The paint may thus be completely eroded from the surface of the panel while the barnacles remain firmly anchored.

Non-toxic Paints

The colors of commercial non-toxic paints and their effect on fouling have been considered. Most previous investigators agree that light-colored, non-toxic surfaces attract fewer sedentary organisms,

during short periods at least, than do darker ones. Phototropic responses of lower organisms which are known to be aroused to maximum activity by different spectral bands are significant. Mast (22) observes that while these forms are not provided with true color vision the photosensitive materials in light-perceiving organs are more sensitive to certain wave lengths than to others.

It has been demonstrated by various investigators that larvae of sessile forms, including barnacles, hydroids, etc., are more active in the blue-green or green bands of the spectrum. A practical application of this knowledge was suggested by Visscher and Luce (34). Their theory is that since cyprids of barnacles are negatively responsive to light just before becoming attached, a green paint should become less fouled than those of darker hues commonly used on the bottoms of boats. Neu (27) found that surfaces coated with green having a wave length of from 543 $\mu\mu$ to 561 $\mu\mu$ were avoided by cyprids of barnacles and collected fewer serpulid worms than did paints of other colors. In experiments at Beaufort, North Carolina, recorded by Williams (35), panels were painted white, yellow, green, blue, and black. In three months the white panels were practically free of organisms, the yellow and green panels slightly fouled, and the blue and black heavily fouled. Williams (35) also cites the results of Mowbray at Bermuda where brown, red, green, and white non-toxic paints were compared for their antifouling properties. In 3 months the green surface was little fouled and in 6 months it supported 75 percent less animal life than any of the other colors, each of which was densely covered with organisms.

In our experiments many non-toxic paints of various colors and shades were utilized. For short periods, up to a month or 6 weeks, surfaces coated with white and green paints were generally more effective in repelling organisms than were those treated with darker colors. White usually showed some antifouling advantage over green. After 2 or 3 months, however, little difference could be detected between colors, all supporting a considerable amount of fouling.

To negate possible effects of the ingredients in the colored paints, parallel experiments were conducted with white, green, red, and blue glass plates, each 24 square inches in area. The results were varied and sometimes contradictory to the above general observation on the effectiveness of white and green surfaces. After colored glass plates were exposed to sea water for 10 days, the white plate had collected

17 organisms of all kinds, the green plate 44, the red plate 85, and the blue plate 130. Before submergence, the green plate showed a maximum transmission at about 540 $\mu\mu$, the red one at about 625 $\mu\mu$ and the blue one at about 460 $\mu\mu$. Under water, however, the accumulation of slime on the surface doubtless alters the transmission property of the glass, and the efficiency of the original color may soon be suppressed. In a 6 weeks' test with colored plates similar to the above, the red and blue plates were 10 percent more heavily fouled than the green ones which accumulated 75 percent more organic matter than did the white plates. Occasionally, however, green plates attracted more organisms than any of the others. During an exposure of 15 days the number of barnacles affixed to both surfaces of the glass plates was as follows: white, 503; blue, 907; red, 1,058; green, 1,152. A comparison of red and green glass plates often revealed little difference in the amount of fouling during periods of 6 to 8 weeks (pl. 5, *A, B*).

The phototropic response of motile organisms at night doubtless varies from that exhibited during the day. Panels, painted and unpainted, were submerged during a night, then examined for affixed organisms and compared with other panels exposed during daylight hours to determine when sessile animals were more readily attached. Daylight tests August 10, 1937 and in the ensuing night showed numerous barnacles, bryozoans, and oysters attached during the day but none at night. During the nights of August 13 and August 19, however, oysters, bryozoans, ascidians, and both cyprids and young barnacles were affixed in considerable numbers to both black and white panels. During the night of August 24, 23 barnacles and 1 serpulid worm became attached to a green painted area of a panel while the unpainted surface of similar area collected 7 barnacles and 1 amphipod tube. During daylight hours of December 22, 1937, an unpainted surface, 20 square inches in area, of a wood panel collected 52 barnacles, 42 colonies of *Schizoporella* and 1 oyster, while an equal area of the same panel, painted black, had attached 26 barnacles, 103 colonies of *Schizoporella*, 45 oysters, and 8 serpulid worms. During the night immediately following, a similar unpainted area had 12 affixed cyprids of barnacles and a black surface of equal area supported 1 barnacle and 1 cyprid.

From the foregoing results which are somewhat conflicting, few definite conclusions can be reached. It seems unlikely that the organ-

isms are capable of discriminating between colors of surfaces in extreme darkness although certain degrees of light intensity may make this possible. Mast (22) points out that not only the maximum stimulating wave bands vary for diffierent organisms but that intensity may modify the results. We suggest that before a specific color is to be considered of major importance in the fouling problem, information is desirable regarding the tropic responses of the larvae of a much wider range of sedentary organisms than is now known and of their behavior under variable light intensity. Though much evidence supports the view that darker colors are more attractive to sessile organisms, Herz (16) has demonstrated that the cyprids of *Balanus crenatus* settle in lighted areas, contrary to the findings of Visscher (33) who worked with different species.

Varnishes, oils, waxes, and creosote have little value in repelling fouling organisms when applied to surfaces. Even toxic paints covered with hard varnishes are soon heavily fouled, probably because the toxic elements of the paint cannot readily enter solution. Creosote, considered to be a good antiseptic but a poor germicide, has little merit in preventing the attachment of sessile animals when applied directly to a surface, as it is quickly diluted by sea water. Fouling occurs on creosoted surfaces about as quickly as on untreated ones (pl. 4, *A*). Panels submerged in creosote for 48 hours before being subjected to sea water prevent fouling for a short time but lose their efficiency even while a strong odor of the compound remains.

Non-toxic Paints with Added Poisons

Investigations were carried on in Kaneohe Bay with commercial non-toxic paints or enamels to which we added poisonous chemicals in an attempt to determine the relative effectiveness of the toxic agents when united with some of the least expensive commercial paints. Compounds of arsenic, cyanide, copper, mercury, and zinc, either singly or in various combinations and amounts, were frequently used.

In general, rapid solution of the chemicals and changes in the paint, on contact with sea water, probably soon wash away or neutralize the toxins to such an extent that sedentary organisms find safe anchorage. While the tests of the added poisons usually indicated some delay in the attachment of organisms, they also disclosed variable results.

Mercuric chloride usually produced the best results. Panels coated with enamels to which mercury was added, either alone or in combination with some of the other poisonous chemicals, frequently reduced or inhibited fouling for 3 or 4 months (pl. 8). The less soluble mercurous chloride was generally inferior to mercuric chloride, probably because it is not dissipated rapidly enough to prevent early attachment of organisms. Once attached, some sessile animals grow rapidly regardless of the nature of the surface to which they are affixed. Laboratory experiments showed that mercuric chloride, both in paint combinations and in solutions, has a more rapid lethal effect on nauplii of barnacles than does mercurous chloride. (See tables 10 and 11.)

Table 10. Effect on barnacle nauplii of solutions of toxic compounds when added to non-toxic enamels (5 grams of poison to 4.74 fluid ounces of enamel) and applied to micro-cover glasses

Toxic compounds	30 mins.	60 mins.	90 mins.	120 mins.
As_2O_3	all swim	nearly all swim all active	as before	95% swim all active
KCN	none swim some active	as before	as before	none swim many active
NaCN	none swim some active	some swim most active	as before	50% swim feebly most active
$HgCl_2$	none active	none active no recovery		
HgCl	all swim	nearly all swim all active	some swim all active	50% swim all active
ZnO_2	all swim	as before	as before	as before
Cu_2O	all swim	as before	all swim some feebly	as before
Cupric oleate	all swim	as before	as before	75% swim all active
Paris green	nearly all swim all active	as before	as before	90% swim all active

Atkins and Purser (4) observed that coal tars with the addition of copper oleate and copper resinate were highly efficient for preserving rope in sea water. Copper oleate served as a lubricant and both copper compounds preserved against bacterial attack. In numerous tests in Kaneohe Bay, copper oleate and copper resinate added to commercial paints had little merit as antifouling agents.

The relative antifouling value of several toxicants when combined with commercial paints or enamels was determined for short periods of time. To each of four quantities of a white enamel was added a toxic compound in the proportion of 1 gram of poison to 4.74 fluid ounces of enamel. Four areas of a wood panel, each 17 square inches, were coated with the enamels, one containing mercurous chloride, one zinc oxide, one Paris green, and the fourth mercuric chloride. An untreated area of similar size on the same panel served as a control. After 14 days in sea water there were 78 barnacles on the area treated with zinc oxide, 26 on that treated with Paris green, 13 on the mercurous chloride area, and only 4 on that treated with mercuric chloride. Many colonies of *Schizoporella* and many amphipod tubes were found on all areas except that containing mercuric chloride where there were only a few amphipod tubes. The unpainted control area supported approximately 400 barnacles. On another panel marked off into equal units, each 15 square inches in area, 5 units were coated with a white commercial enamel, that for each area having added to it a different toxicant, the proportion being 5 grams of the poison to 4.74 fluid ounces of the enamel. The number of barnacles attached to each treated area, after 49 days (December 8, 1936 to January 26, 1937) was: copper oleate, 129; sodium cyanide, 71; copper oxide, 45; zinc oxide, 30; mercurous chloride, 24. Five units of this panel were unpainted. The number of barnacles carried by these areas ranged from 200 to approximately 500.

Under controlled laboratory conditions tests were made to determine the relative effect on nauplii of barnacles of certain toxic compounds when added to commercial non-toxic paints or enamels. Micro-cover glasses 22 mm. square were painted on one side with two coats of white enamel to which had been added 5 grams per 4.74 fluid ounces of enamel of the toxicants listed in table 10. When the coatings were dry each cover glass was placed in a watch glass containing 10 cc. of normal sea water. Many active nauplii were introduced and their behavior noted after periods of 30, 60, 90, and 120

minutes (table 10). Under the conditions of this experiment, mercurous chloride, probably because of its low solubility, does not have the rapid lethal effect shown by mercuric chloride. For similar or other reasons several of the toxic compounds listed in table 10 had little injurious effect on nauplii during the first 2 hours. After 18 hours in these solutions, nauplii showed signs of activity only in those treated with zinc oxide and copper oxide. Inactive specimens under the influence of Paris green for 18 hours exhibited slight activity when returned to normal sea water. None of the nauplii survived for 24 hours in any of the toxic solutions.

Laboratory experiments were also conducted to determine the resistance of nauplii to weak solutions of various toxic compounds in sea water. Solutions of arsenious oxide, copper oxide, mercuric chloride, mercurous chloride, potassium cyanide, sodium cyanide, zinc oxide and Paris green were used in the strength of 1 part to 100,000. The behavior of nauplii subjected to the solutions was noted after periods of 15 minutes, 1, 11 and 18 hours. The results were, in general, parallel to those in which the same toxicants were used in enamels. (Compare tables 10 and 11.) After 36 hours in copper oxide and zinc oxide solutions some activity of nauplii was seen, and some specimens in the cyanide solutions were able to swim. Atwood and Johnson (6)[5], in noting the lethal effects of salts of metals on *Limnoria* and *Bankia,* concluded it made little difference what salt of a metal was used. In rating the toxic values of metals they placed mercury first, copper second, and zinc third.

Analyses of sea water have revealed but traces of zinc, a metal known to be highly toxic to some marine organisms. Atkins (3) who reports Orton as having found less than 0.1 part per million in the waters of the English Channel, records that lobsters confined in a galvanized iron aquarium with a strong current of water died in 4 days, at which time the aquarium water contained 25 parts of zinc per million. It may be assumed that under the conditions of our experiments (table 10) the effect of zinc was negligible during the first 2 hours because little of the metal had entered solution. It is seen, however, that in solutions with a much higher percentage of zinc than contained in normal sea water nauplii were active for at least 18 hours.

Arsenic added to enamel had little effect on nauplii during the first 2 hours (table 10). In solution, it was fatal to the organisms

[5] Investigation by R. H. Carter.

within 18 hours (table 11). That appreciable amounts of arsenic are in sea water chiefly in the form of arsenite, was suggested by Atkins and Wilson (5) and verified later by Rakestraw and Lutz (31). Many marine animals carry arsenic in their tissues apparently without ill effects. Chapman (8) found as much as 174 parts per million in certain prawns. Fishes, lobsters, mollusks, and seaweeds also contain considerable quantities of arsenic.

Table 11. Resistance of nauplii of barnacles to toxic compounds in solutions 1 part to 100,000

Toxic compounds	15 mins.	1 hr.	11 hrs.	18 hrs.
As_2O_3	nearly all swim all active	as before	inactive revive in sea water	inactive no recovery
KCN	inactive revive in sea water	as before	many swim nearly all active	some swim feebly others active
NaCN	inactive revive in sea water	as before	nearly all swim all active	as before
$HgCl_2$	inactive no recovery			
HgCl	all swim	as before	inactive no recovery	
ZnO_2	all swim	nearly all swim all active	as before	some swim many active
Cu_2O	all swim	as before	as before	some swim all active
Paris green	all swim	as before	some swim all active	none swim some active

Paris green added to enamel had little effect on nauplii during the first two hours (table 10). Nor was it highly toxic in solution for a period of 11 hours (table 11). Adamson (1) reports that the United States Navy found Paris green of little value as an antifouler when used alone but efficient when combined with mercury.

It is assumed that some toxic compounds combined with paints enter solution quickly in sea water and are soon expended or neutralized by the action of other ingredients of the paint. In either case fouling organisms are permitted to gain a foothold on the treated surface. To determine the rapidity of solution of some of the poisons used in the preceding test (table 10), a number of micro-cover glasses were coated with poisoned enamel as before but subjected to circulating sea water for 8 days after which experiments were conducted with nauplii as previously described (p. 281). An apparent loss of toxicity was noted for each of the poisons. Nauplii were killed quickly by mercuric chloride in the first experiment but in the second survived 6 hours or more, but did not survive 20 hours. The nauplii resisted the influence of other toxic agents for more than 24 hours, little injury being done by any except potassium cyanide which inhibited the swimming activities of the organisms, though it was not fatal during the period of observation.

Commercial Antifouling Paints

Manufacturers of marine paints have been mindful of the demands of ocean commerce for some relief against fouling organisms. Numerous proprietary paints to which have been ascribed the property of antifouling are available. Some of these have been widely used with varied results. While they are recommended, there is no assurance on the part of the manufacturers that their products are absolute and permanent repellents of sessile organisms. The high cost of some of the antifouling coatings doubtless has limited their use, as the owner of a craft hesitates to buy the higher priced product unless he can be shown that it has increased merit.

Extensive investigations have shown that the most highly recommended antifouling paints are of temporary benefit only. Visscher (32), who observed that organic matter 2 or 3 inches deep often accumulated on the bottoms of ships treated by antifouling coatings after they had been at sea for 6 or 8 months, concluded that none of the toxic paints in use was a successful repellent of fouling organisms for extended periods. The experiments of Neu (p. 276) emphasize this fact, which is the conclusion of all who have carried on similar tests. Orton (28) found that some antifouling preparations were satisfactory for more than 3 years while others were effective for a few weeks only. This investigator pointed out that an antifouling

coating should adhere firmly to the surface, resist erosion, and prevent attachment of organisms by reason of its toxic ingredients. Orton also showed that the efficiency of the paint was lost when its toxicity fell below a certain concentration. Neu (27) called attention to the fact that the toxicants used in paints did not take into consideration the variation in susceptibility of different organisms. This biological factor is probably of no little importance and one about which little is known except through restricted laboratory experiments which usually lack natural conditions.

During the course of our observations in Kaneohe Bay, 8 commercial antifouling paints were extensively tested to determine their relative efficiency in repelling sessile organisms. The findings for the several toxic coatings used were drawn from results under conditions of the experiments as performed. There is no implication that if a modified form of application of the paints were employed or the nature of the surfaces of the panels were different the results would be identical. Our method consisted in applying with a brush two thick coats of paint to a panel as evenly as possible. The surface was permitted to dry thoroughly between coats and before being submerged in the water.

The following toxic paints, designated by their trade names, were used in our experiments and applied to panels of many kinds: Yacht Green (Fuller Co.), Marine Green (Fuller Co.), Copper Red (Fuller Co.), Federal Antifouling (Federal Composition and Paint Co.), Antifouling Germicide (International Paint Co.), Cape Cod (American Marine Paint Co.), Yacht Bottom Enamel (Glidden Co.), and Antifouling Composition (Debevoise Co.). Of these the first two are green, as the names indicate, the last two are white and the others are copper colored.

We treated approximately 300 panels with toxic paints, some of them being used more often than others but all given fair and extensive tests during all seasons of the year. Most of the paints tested proved to be effective for periods up to 3 or 4 months, under the conditions of our experiments. Some of them remained free of organisms for 6 months and in exceptioned instances retained sufficient toxicity to resist fouling for more than a year.

Yacht Green rated high among the paints tested. This coating creates a smooth, hard surface and withstands erosion well; panels treated with it come out of the water relatively free from slime and

silt. It is usually a dependable repellent of nearly all fouling organisms for periods up to 6 months and often for a longer time (pl. 6, *A, B*). Marine Green also has a good body, unites firmly to a surface, and, in most of our tests, has proved quite as efficient as Yacht Green (pl. 5, *B*).

If the light hue of a surface has any merit in itself in preventing the settling of organisms (p. 277), a white antifouling paint should be especially efficient provided its general qualities, including toxicity, are adequate. Of the white paints used in our tests, Yacht Bottom Enamel was the least effective, usually fouling quickly. Antifouling Composition generally proved to be a good repellent of most organisms for periods of several months (see pls. 7 *A*; 9, *B*). As applied to our panels, however, there was a tendency for this coating to shrink, crack and erode after a few months, resulting in a roughened surface and permitting footholds for sessile organisms.

The four copper-colored paints seem to be about equally efficient as antifoulers. Like other toxic coatings, these copper paints often inhibited fouling for several months, but at other times were effective for only a few weeks. (See pls. 5, *B*; 6, *B*; 7; 9, *A*.) Cape Cod paint, while not always a dependable repellent for extended periods, has occasionally completely inhibited fouling for more than a year (pl. 7, *B*).

As may be inferred, the results of our experiments are by no means uniform. When sudden reproductive outbursts of organisms occur, toxic paints, generally considered most effective, have been fouled almost as quickly and completely as untreated surfaces.

To determine the relative lethal effect on barnacle nauplii of the several antifouling paints under laboratory conditions, experiments were conducted similar to those in which non-toxic paints with added poisons were used. (See p. 279 and table 10.) Micro-cover glasses were coated with the toxic paints and covered by 10 cc. of normal sea water into which were introduced active nauplii. The behavior of the organisms in the various solutions is shown in table 12. Yacht Green, Federal Antifouling, Antifouling Germicide, and Yacht Bottom Enamel were each lethal to nauplii within 3 hours. In the other preparations, some activity of specimens persisted for another hour or two but none survived for 18 hours.

Table 12. Effect on barnacle nauplii of solutions of seven commercial antifouling paints applied to micro-cover glasses

TOXIC PAINTS	30 MINS.	60 MINS.	90 MINS.	120 MINS.
Yacht Green	few swim all active	no activity	as before no recovery	
Marine Green	all swim	most swim all active	many swim all active	many swim most active
Federal Antifouling	all swim	many swim feebly all active	none swim some active	as before
Cape Cod	all swim	most swim all active	many swim all active	few swim many active
Antifouling Germicide	all swim	most swim all active	few swim many active	few swim feebly many slightly active
Antifouling Composition	all swim	as before	most swim all active	as before
Yacht Bottom Enamel	all swim	most swim all active	some swim feebly all active	none swim some active

To determine the loss of toxicity in commercial antifouling paints on short exposure to sea water, micro-cover glasses were coated with four of the more efficient preparations, Federal Antifouling, Yacht Green, Antifouling Composition, and Cape Cod. They were then submerged in circulating sea water for 8 days after which the resistance of nauplii to each was observed, following the methods of the preceding experiment. Results indicated that all paints had lost considerable toxicity. In the previous test Yacht Green was fatal to nauplii in 90 minutes (table 12), but after 8 days in sea water the lethal properties were reduced to the extent that specimens were able to swim feebly after 4 hours and still showed activity after 8 hours. Federal Antifouling and Cape Cod were reduced in toxicity parallel with that of Yacht Green, activity of nauplii persisting for at least 8 hours. Antifouling Composition failed to inhibit the swimming response in 8 hours and many specimens showed activity after 18 hours.

SUMMARY

This paper presents the results of a biological survey in which the principal fouling organisms of Kaneohe Bay, Oahu, were determined, and their seasons of greatest productivity, their rate of growth and general ecology were investigated. In this locality fouling occurs throughout the year but declines during the months of January and February, probably because of environmental factors such as lower temperature and frequent turbidity and dilution of surface waters by heavy rainfall.

The rate of growth of the principal fouling organisms—barnacles, bryozoans, serpulid worms, oysters, and ascidians—in favorable seasons is usually rapid during the first month then slows to a more steady increase. *Balanus amphitrite* normally matures in from 40 to 60 days, when it reaches about 15 mm. in diameter, but occasionally reaches that state at a smaller size and within 30 days. The species lives in local waters for several years and attains a diameter of from 22 to 26 mm.

Bugula neritina reproduces when about 25 mm. tall and about 2 weeks old. Colonies seldom reach a height of 100 mm. or live more than 3 months. *Schizoporella unicornis* ? increases in diameter about 1 mm. per day for 30 to 40 days and attains a diameter of 60 to 70 mm. in about 3 months. No information on size at maturity or longevity of the species was obtained.

Tubes of serpulid worms were developed to a length of about 30 mm. in as many days, when maturity was reached. *Hydroides norvegica* attains a tube length of 50 to 60 mm. in 3 or 4 months while tubes of *H. lunulifera* have slightly exceeded 100 mm. in length in about 10 months. The duration of life of serpulid worms was not determined.

A thin-shelled oyster, *Ostrea thaanumi,* attained a diameter of 50 mm. in about 10 months. Data on size at maturity or length of life of the species were not obtained.

During spring and summer the spread of compound ascidians over surfaces is rapid. Simple ascidians have reached a length of 70 mm. within 14 months. No information was obtained on the age of these forms at maturity or their duration of life.

The behavior of various organisms under altered conditions was observed in laboratory tests. Resistance, especially of barnacles and serpulid worms, to changes in temperature, to fresh water, to diluted

sea water, to desiccation, etc., was determined. Nauplii of barnacles are less resistant to changes in environment than are adults. Fresh water is fatal to nauplii in 15 minutes while adult barnacles have endured this medium for 9 days. Serpulid worms in tubes and adult barnacles are maintained in a mixture of three fourths sea water and one fourth fresh water for nearly 2 months, and the barnacles endure a half and half mixture of sea water and fresh water for approximately as long. Serpulid worms are more sensitive to this dilution than are barnacles. Adult barnacles live after 3 days in a constant temperature of -1° C. while nauplii endure 8.5° C. for about 4 days. At constant temperature of 35° C. nauplii are slightly less resistant than adult barnacles, the latter living a little over 3 days.

Adult barnacles will live out of water in shade for 27 days with a maximum air temperature of 26° C. Serpulid worms in tubes die out of water in the shade usually within 24 hours. Bright sunlight with air temperature at 45° C. is fatal to adult barnacles in 3 or 4 hours.

Serpulid worms and oysters seem to prefer attachment at lower levels in the water than do other fouling organisms.

Of 9 metals used, copper, brass, German silver, and zinc were more effective than others in repelling sedentary organisms. Copper or brass plates when brought into close contact with iron or tin foul quickly.

Greater fouling on shaded or dark surfaces seems to indicate that negative phototropism on the part of the larvae obtains at the time of attachment. However, settling of organisms occurs as freely at night as during daylight hours, an observation which challenges the view that color of surface is an important factor in fouling. White surfaces have an antifouling advantage over darker ones, for short periods of time. Sometimes green panels repel organisms to a greater degree than red or blue ones if all are non-toxic; often the reverse is true. Spectral colors apparently have little differential value after periods of one or two months.

Poisonous compounds added to non-toxic commercial paints give to the latter slight antifouling properties. Of the toxicants used, mercuric chloride in high concentrations is generally more effective than others. Laboratory experiments to determine the sensitiveness of nauplii of barnacles to 8 poisonous compounds in enamels and in solutions verified the high value of mercuric chloride as a lethal agent.

Eight commercial antifouling paints were tested. Most of them were satisfactory under conditions of our experiments for 3 or 4 months, some for 6 months and occasionally for a longer time. During periods of high productivity of organisms, however, even the coatings usually most effective were often readily fouled.

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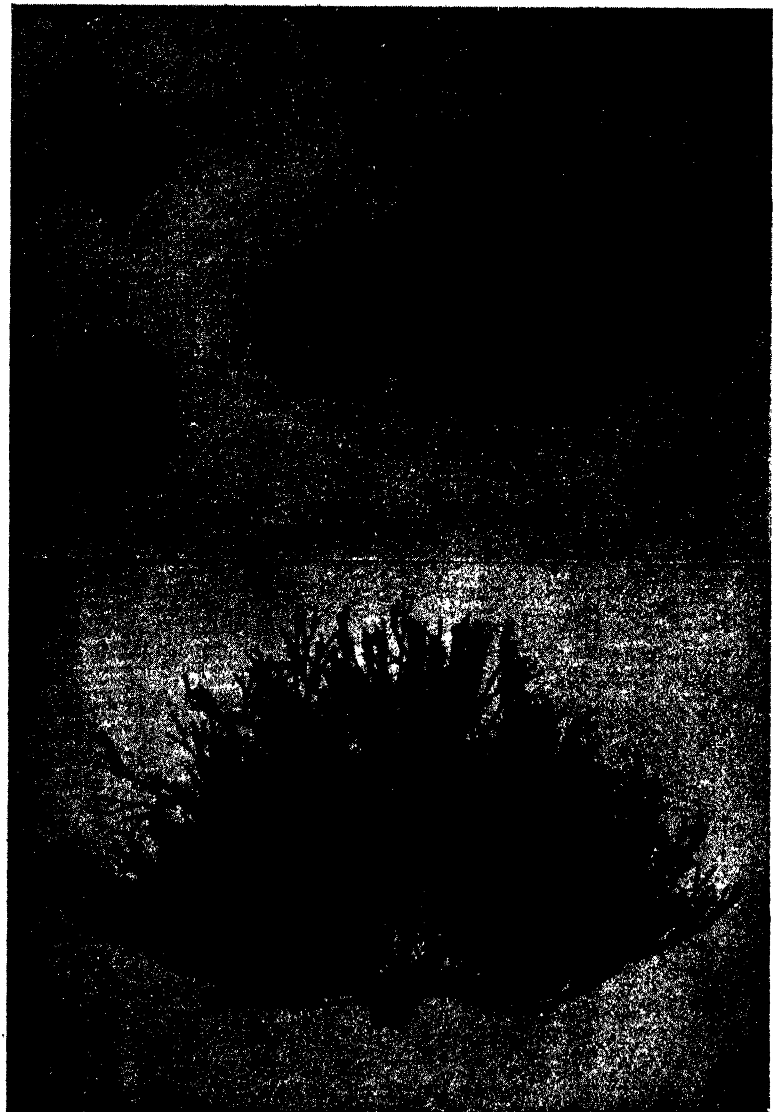


PLATE 1.—Barnacles and bryozoans, natural size. *A, Balanus amphitrite* 126 days old; *B, B. amphritrite* about 3 years old; *C*, fused colonies of *Schizoporella unicornis* ? 35 days old; *D*, colony of *Bugula neritina* 91 days old.

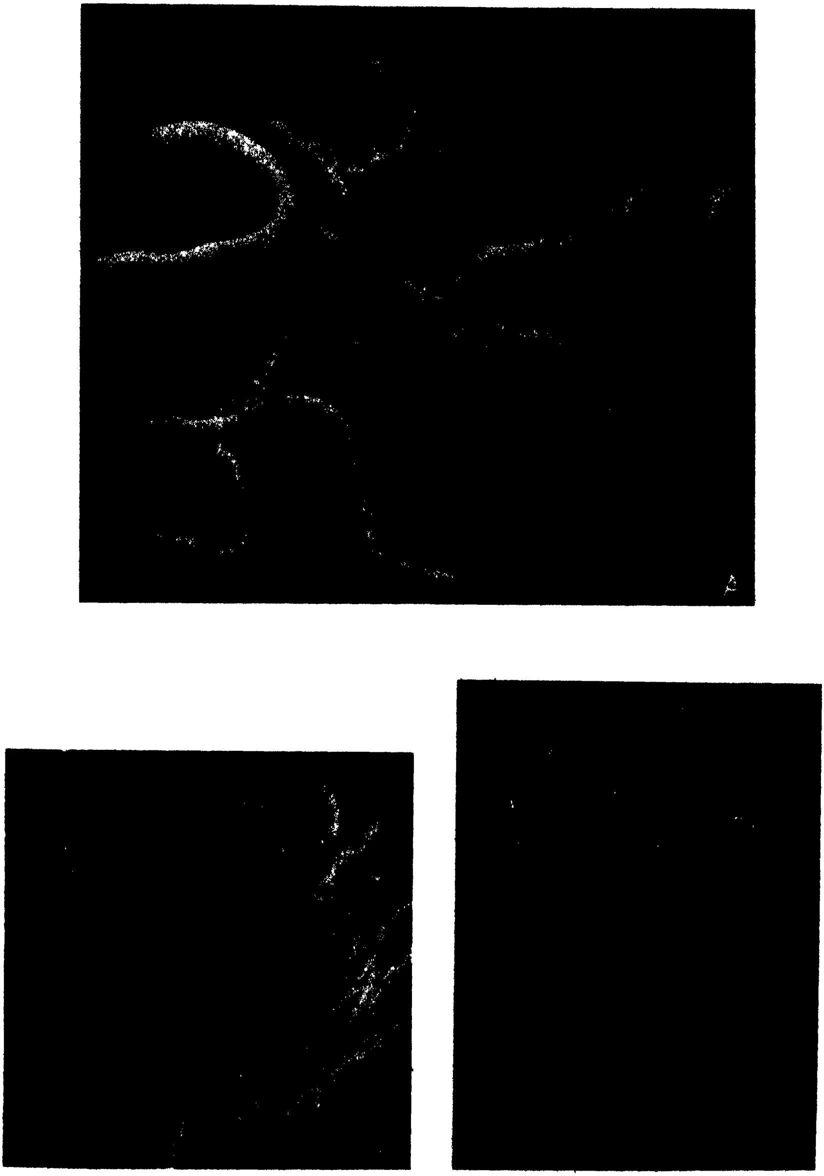
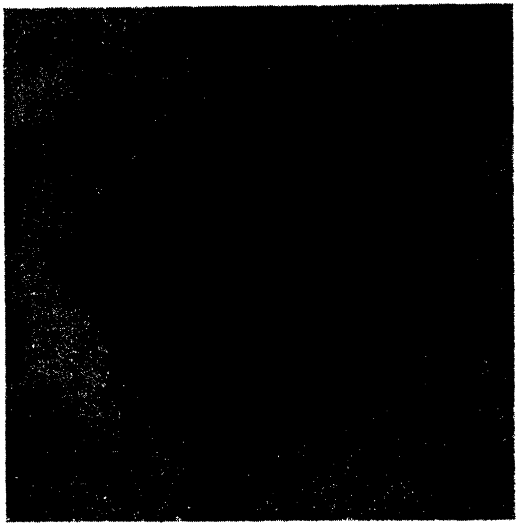


PLATE 2.—Serpulid worm tubes. *A*, group of *Hydroides lunulifera* overlying colonies of encrusting bryozoans; *B*, tubes of *H. norvegica*; *C*, mass of tubes of *Salmacina dysteri*. All × 1.5.



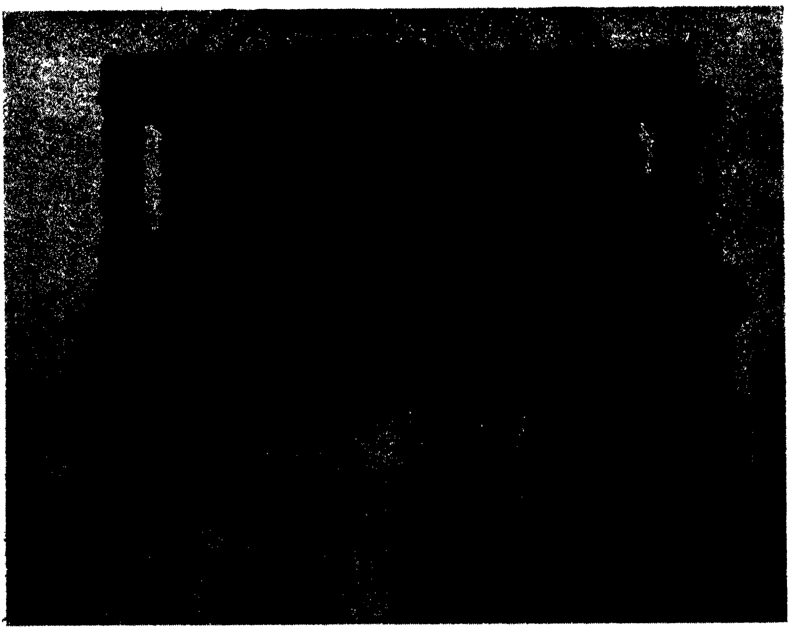


PLATE 3.—*A*, *Ostrea thaanumi*, 322 days old, natural size; *B*, wood frame 19 inches long, supporting glass plates, in sea 69 days. Heavily fouled by compound ascidians.

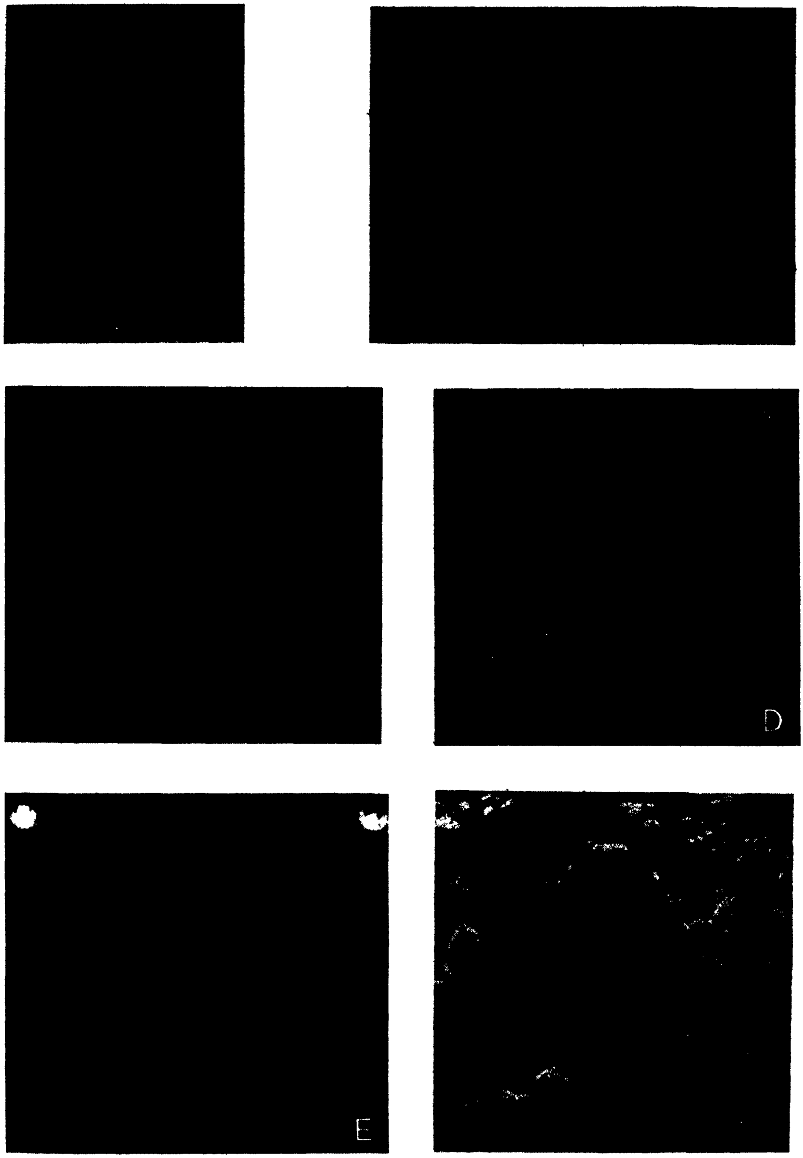


PLATE 4.—*A*, wood panel 6 × 9 inches, in sea 63 days; upper half coated with creosote, lower half with white non-toxic enamel. *B*, tin (left), brass (center), and galvanized iron (right) plates coupled together; brass fouled after 38 days. *C-F*, metal plates 4 × 4 inches, in sea 30 days: *C*, brass; *D*, iron; *E*, copper; *F*, tin; brass and copper unfouled, iron fouled by serpulid worms, tin by barnacles and compound ascidians.

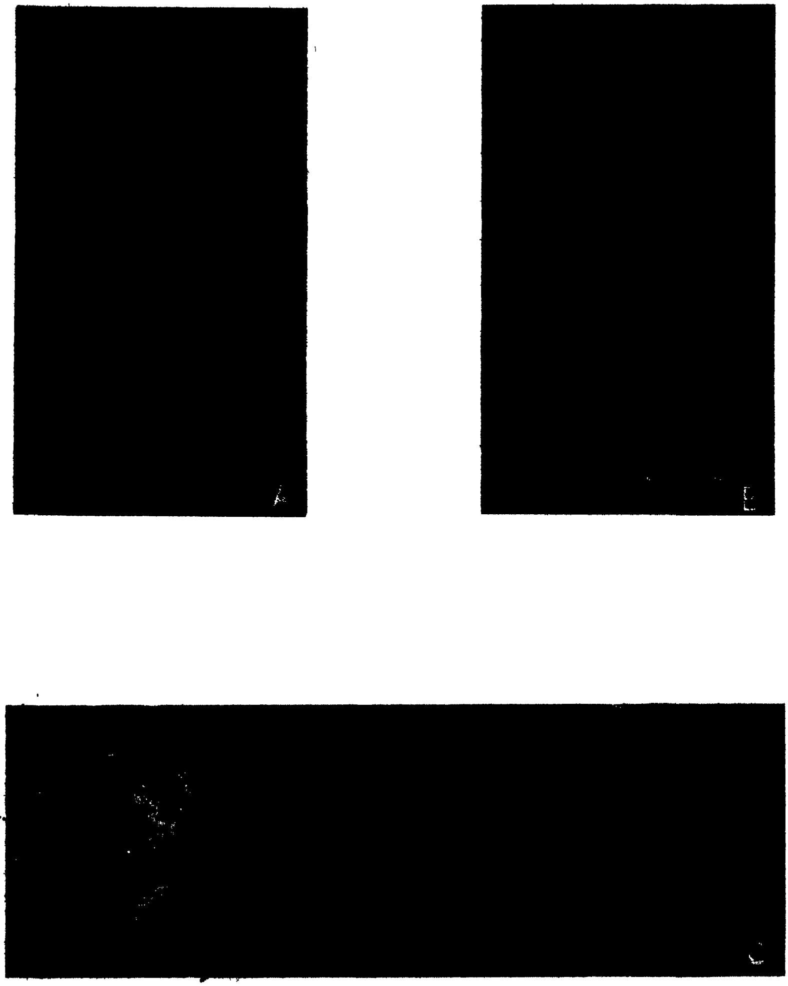
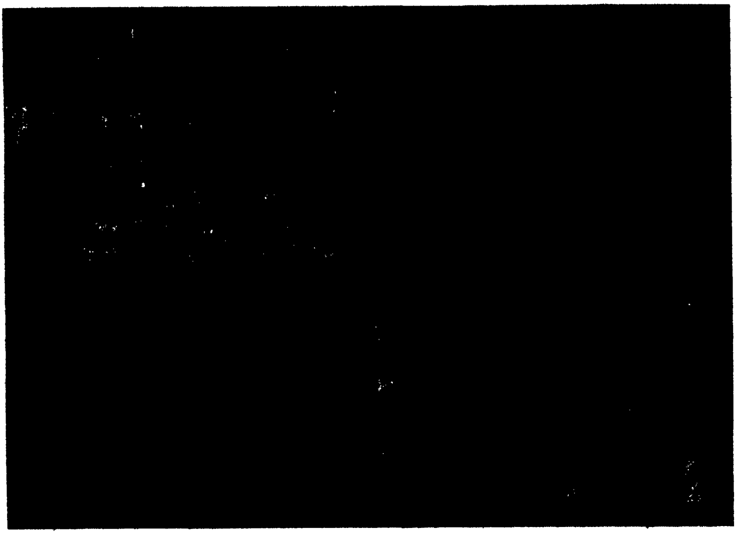


PLATE 5.—*A*, *B*, colored glass plates 4 × 6 inches, fouled after 48 days in sea: *A*, green; *B*, red. *C*, Masonite panel, 6 × 17.5 inches, in sea 139 days; left section coated with Kress green enamel plus 1 gram $HgCl_2$ per 4.74 fluid ounces, other sections, left to right, coated with Federal Antifouling, Marine Green, and Cape Cod.



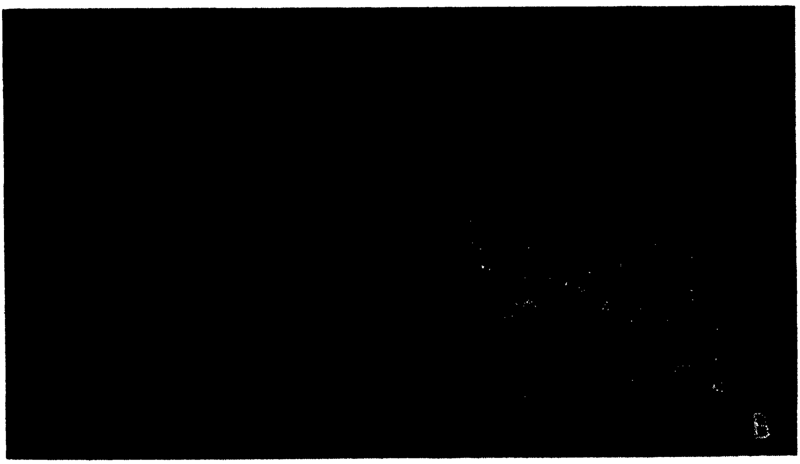


PLATE 6.—*A*, wood panel, 8.5 × 12 inches, in sea 67 days: Areas coated as follows: upper left, Superwhite enamel plus 10 grams Cu_2O, 5 grams As_2O_3 and 5 grams ZnO_2 per 4.74 fluid ounces; upper right, Kress Lettuce Green enamel, normal; lower left, Yacht Green; lower right, Superwhite enamel, normal. *B*, Masonite panel, 8 x 12 inches in sea 9 months and 18 days: coatings as follows: upper left and lower right, Superwhite enamel, normal; upper right, Yacht Green, lower left, Copper Red.

PLATE 7.—*A*, wood panel 12 × 12 inches, in sea 115 days: Coatings as follows: upper left Superwhite enamel plus 5 grams Cu_2O per 4.74 fluid ounces; upper right, Federal Antifouling; lower left, Cape Cod; lower right, Antifouling Composition. *B*, Masonite panel, 8.5 × 12 inches, in sea 383 days. Left half unpainted; right half painted with Cape Cod.

PLATE 8.—*A,* wood panel, 9.5 × 18 inches, in the sea 122 days: Coated with Kress white enamel, left half normal; right half plus 30 grams $HgCl_2$ per 4.74 fluid ounces. *B,* Masonite panel, 6 × 12.5 inches, in sea 3 months and 14 days. Coated with Kress white enamel, left third plus 1 gram $HgCl_2$, right third plus 1 gram Cu_2O and middle third 1 gram KCN, each per 4.74 fluid ounces.

PLATE 9.—*A,* Masonite panel, 9 × 12 inches, in sea 133 days: Upper half coated with Antifouling Germicide, lower half with Superwhite enamel plus 10 grams $HgCl_2$, 5 grams Cu_2O, and 5 grams As_2O_3 per 4.74 fluid ounces; *B,* Masonite panel, 8 × 14 inches, in sea 177 days: Left half coated with Glidden white enamel, normal; right half with Antifouling Composition.

OCCASIONAL PAPERS
OF
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV January 25, 1939 Number 15

Revision of the Fijian Ottistirini (Coleoptera, Curculionidae)

By ELWOOD C. ZIMMERMAN

INTRODUCTION

In 1930, the late Arthur M. Lea described two new genera and three new species of the subfamily Brachyderinae from Fiji (Linn. Soc. N. S. Wales, Proc., **55**: 461-464). These belong to the tribe Ottistirini which was revised by Dr. K. M. Heller (Wien Ent. Zeit, **42**: 55-91, 1925). Through the courtesy of the South Australian Museum at Adelaide and its director, Dr. Herbert M. Hale, it has been my privilege to study Lea's types of these three Fijian species.

The tribe Ottistirini is largely confined to the Malay-Papuan region where it reaches its greatest development in New Guinea and the East Indies; there are a few species known from Australia, Fiji, and Samoa. It is represented outside these regions by one genus (*Syzygops* Schönherr) confined to Reunion and Mauritius Islands in the Madagascar region.

In this paper I have revised the Fijian Ottistirini, added a new genus, two new species, and a new subspecies, and made some necessary corrections. I have examined the types of all the known Fijian Ottistirini and cotypes of the Samoan species. From these type specimens I have redescribed all of the genera and species known from Fiji.

I wish to thank Dr. Herbert M. Hale for the privilege of examining Lea's types and Sir Guy A. K. Marshall for sending to me for study the unidentified Fijian Ottistirini from the British Museum.

List of the Fijian Ottistirini

1. **Leacis vitiensis** (Lea) Zimmerman, new genus and combination.
2. **Nesogenocis cucullus** Lea.
3. **Viticis bidentatus** Lea.
4. **Ottinychus comptus** Zimmerman, new species.
5. **Ottinychus gemmatus** Zimmerman, new species.

5a. **Ottinychus gemmatus griseus** Zimmerman, new subspecies.

Key to the Genera

1. Epistome delimited posteriorly by a deep, distinct transverse sulcus..........2
   Epistome not delimited posteriorly by a deep, transverse sulcus......................3
2. Tarsi with single claws, prothorax normal..**Leacis**
   Tarsi with two claws, connate at base but distinctly divergent distally; prothorax with apical part bent downward and there on about the same plane as front of head..**Nesogenocis**
3. Tarsi 3-segmented, lacking a claw segment, the third segment broad, truncate at apex; femora toothed; funicle of antennae 6-segmented .... **Viticis**
   Tarsi 4-segmented, the claw segment distinct, bearing a single claw; femora edentate; funicle of antennae 7-segmented......................**Ottinychus**

All the Fijian Ottistirini fall near *Ottistira* in Heller's key to the genera. They have all the coxae distinctly separated, the hind tibiae unarmed at the apex, except in *Viticis,* and the metasternum with a post-median fovea.

Genus **LEACIS**, new genus

Rostrum with epistome delimited posteriorly by a distinct sulcus, interscrobal area at antennae three fourths as broad as interocular area; scrobe passing straight downward and posteriorly halfway between eye and epistomal suture. *Antennae* with scape projecting but little below lower margin of rostrum, funicle 7-segmented, the first two segments elongate, the first larger than the second. *Prothorax* slightly broader than long. *Scutellum* visible. *Elytra* with prominent humeri, ten striate. *Sternum* with all coxae distinctly separated; metasternum with a distinct median fovea before the hind margin. *Legs* with femora edentate; fore tibiae arcuate, the others nearly straight; fore and mid tibiae armed with a strong mucro, hind pair unarmed; tarsi with second segment much broader than long, almost as broad as third which is broad and deeply bilobed, the fourth segment projecting far beyond anterior margin of third and distinctly armed with only one claw.

Genotype: *Eutinophaea vitiensis* Lea.

In Heller's revision the species for which this genus is erected runs to *Ottistira* Pascoe, but it differs from that genus in having only a single claw on the tarsi. According to Marshall the interscrobal area on *Ottistira* is nearly as broad as the interocular area, but in this genus it is distinctly narrower.

It is evident that Lea did not see Heller's revision of the tribe or he would not have placed *Leacis vitiensis* in *Eutinophaea* Pascoe. He considered *Ottistira* a synonym of *Eutinophaea,* but I follow Heller in maintaining them as distinct. According to Heller, the anterior coxae are contiguous in *Eutinophaea* whereas they are distinctly separated on *Ottistira.*

I have named this genus after Lea in recognition of his work on the Fijian fauna.

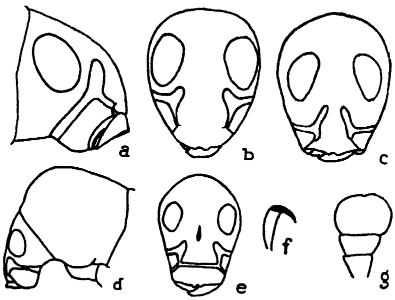


FIGURE 1.—Details of Fijian Ottistirini: *a,* side view and *b,* front view of head and rostrum of *Ottinychus gemmatus*; *c,* front view of head and rostrum of *O. comptus*; *d,* side view of prothorax, head and rostrum of *Nesogenocis cucullus*; *e,* front view of head and rostrum of *Leacis vitiensis*; *f,* claw segment of *L. vitiensis*; *g,* tarsus of *Vitiris bidentatus.*

1. **Leacis vitiensis** (Lea), new combination (fig. 1, *e-f*).

Eutinophaea vitiensis Lea: Linn. Soc. N. S. Wales, Proc., **55**: 461-462, 1930.

Derm pale to dark reddish brown; densely clothed above with rounded, pale and dark brown scales, those on crown of head dark brown, elsewhere on head and rostrum paler; pronotum with pale brown scales, with two broad longitudinal vittae of dark brown scales; elytra variegated with patches of pale and dark brown scales; legs with pale brown scales; scaling below paler; scales usually with an iridescent luster.

Head with derm nearly concealed by scales, front slightly flattened, with elongate median pit beyond middle, interocular area about one and a half times as broad as eye, space between eye and prothorax slightly more than half length of dorsal part of scrobe. *Rostrum,* excluding mandibles, much broader than long, with interscrobal area subtrapeziform, densely squamose, epistomal suture deep; epistome shining, with a few erect setae but free from scales. *Antennae* with scape almost as long as first six funicular segments; funicular segment one as long as two plus three, three fifths as broad as long and more than twice as broad as two, three to seven successively more transverse, club large, as long as the preceding five funicular segments and nearly as broad as long. *Prothorax* slightly broader than long (2.3:2.0), arcuate on sides, broadest at middle, trun-

cate at base and there broader than apex which is arcuate, dorsum gently convex; punctuation dense throughout, punctures concealed by scaling and each containing a short, fine, recumbent seta. *Scutellum* small and pointed, densely clothed with black scales. *Elytra* more than twice as long as prothorax (4.5:2.0) and about three fourths as broad as long; base emarginate at middle, broadest at prominent, roundly angular humeri, thence subparallel-sided to the declivity where humeri are subapically constricted; striae fine, narrow and distinct throughout; intervals several times as broad as striae, smooth and even. *Legs* densely squamose, fore and middle tibiae armed at inner apical angle with a strong mucro, hind tibiae unarmed. *Sternum* with prosternum squamose; mesosternal process about as broad as long, squamose; metasternum squamose on sides but denuded and shining in middle, impunctate and with a few setae; posterior median fovea rather large and conspicuous. *Venter* shining, with intercoxal piece angulate, first ventrite squamose along basal margin and at sides only, with a row of large punctures at base and another before apex, more or less soldered with two, the suture between them angulate; ventrite two with large, round, scattered punctures, with a few scales on the sides only; ventrites two and four with a single row of large setiferous punctures; ventrite five with large, round, scattered, setiferous punctures. Length, 2.6-2.8 mm.; breadth, 1.2 mm.

Viti Levu, Fiji. Holotype female in Lea's collection in the South Australian Museum at Adelaide.

Lea stated that "the claws from most directions appear to be single, but, as on *variegata,* they are slightly separated at the tips." I have carefully examined his type and cotypes under high magnification and find that the claws are distinctly single and solid.

Two small specimens, one of them a male with its aedeagus protruding, mentioned by Lea in his description and labeled as cotypes, do not belong to the same genus as his type. They lack the epistomal sulcus and belong to *Ottinychus* Marshall.

I have before me a male of *Leacis vitiensis,* collected by C. E. Pemberton at "Lami," Fiji, 1920, and sent to me from the British Museum, that differs little from Lea's female type in size and structure. It is interesting to note that on the male and on three other specimens that appear to be males, the first ventrite is longer than the second. On two specimens which I consider females, however, the second ventrite is as long as the first.

The color is subject to some variation. On one of Lea's cotypes the scales are grayer than on typical specimens. Two specimens collected by E. H. Bryan, Jr., at Colo-i-Suva, Viti Levu, June 21, 1924, are much darker, but they are old and somewhat abraded.

Genus NESOGENOCIS Lea, 1930

Head with interocular area only as broad or slightly broader than interscrobal area. *Rostrum* with the epistome delimited posteriorly by a distinct suture; scrobe passing downward nearer to eye than to epistomal suture. *Antennae* with scape projecting slightly below the lower margin of rostrum; funicle 7-segmented, the first two segments elongate, the first larger than the second. *Prothorax* about as broad as long, strongly expanded at middle; base appearing narrower than apex from above; apical third strongly bent downward presenting a broad, subvertical, apical face that is nearly continuous with outline of head and rostrum.. *Scutellum* visible. *Elytra* with prominent humeri, ten striate. *Sternum* with coxae distinctly separated; metasternum with a large post-median fovea and rather deeply grooved before each hind coxae. *Legs* with femora unarmed, anterior tibiae strongly arcuate, the others only slightly so, fore and mid tibiae armed with a strong mucro, hind tibia unarmed; tarsi with third segment deeply bilobed, fourth bearing two claws, connate at base but distinctly divergent beyond the middle.

Genotype: *Nesogenocis cucullus* Lea.

This genus is easily recognized among the known Fijian Ottistirini by its peculiar prothorax. It resembles some members of the genus *Ittostira* Heller 1925, but in that genus the fore coxae are contiguous.

Lea stated in his original description that "there is a slightly thickened, transverse ridge on each side of the scutellar position, but the scutellum itself is absent." However, the scutellum on his type and cotype is distinct and even protuberant, but small. His holotype is mounted on a card and is tipped over nearly on its back so that the scutellum is rather hard to see, but it is present. The genus is known only from Fiji.

2. **Nesogenocis cucullus** Lea (fig. 1, *d*).

Nesogenocis cucullus Lea: Linn. Soc. N. S. Wales, Proc., **55**: 464, 1930.

Derm pale to dark reddish brown, densely clothed above with small, rounded, strongly imbricated scales that normally completely conceal derm; scaling predominantly dark brown variegated with pale patches, scales reticulate and with a slight iridescent cast; crown of head with dark brown scales, base of rostrum, most of interocular area, cheeks and a band around each eye of white or pale greenish scales; prothorax with a pale band at apex, a pale patch on each side above coxae, with or without a vague basal, median, pale vitta, with an interrupted pale vitta on each side of the middle, elsewhere with dark brown scales; elytra with a pale patch on intervals three to six at base, with a vague transverse pale fascia at top of declivity, elsewhere with dark brown scales variegated with spots and patches of pale scales; scaling on legs and below pale.

Head with eyes coarsely faceted and convex, separated from the prothorax by a distance about equal to that between their anterior margins and the scrobe,

front depressed at base of rostrum; interocular area the same breadth as narrowest parts of interscrobal area. *Rostrum,* without mandibles, broader than long; the epistomal suture distinct but not deep; epistome shining, with a few long, slender setae; the squamose area between eye and scrobe about half as broad as squamose area between scrobe and epistome. *Antennae* with club of scape projecting below level of rostrum, scape almost as long as funicle excluding club; funicle with first segment longer than two plus three, as broad as the length of two; two about as long as three plus four; club seven tenths as broad as long, longer than the preceding six segments. *Prothorax* almost as long as broad, base much narrower than apex, truncate; rather straightly expanded on sides to middle and thence almost hemispherical; longitudinal dorsal outline rising rather gently to reach its highest point well beyond the middle and thence rapidly rounding to anterior declivity which is almost straight, but impressed just before apex, and on about the same plane as head, the distance between the highest point of pronotum and apex equal to that from base of head to scrobe; scaling very dense; punctuation rather coarse and close on disk, contour of punctures followed by scales, each puncture bearing a minute seta. *Scutellum* pointed and clothed with black scales. *Elytra* but little broader than prothorax, over two thirds as broad as long (4.5:6.0), and only a third longer than prothorax in about the same proportion; subparallel-sided from base to about middle and thence roundly narrowing to apex; basal margin shining and denuded on each side of scutellum; intervals several times as broad as striae, moderately convex. *Legs* with anterior tibiae with long hairs on inner side. *Sternum* with fore coxae separated by a distance about equal to that between fore margins of prosternum and fore coxae; prosternum bare between coxae, but with a band of scales behind them, mesosternum bare with the exception of a few scales at apex of intercoxal piece, with a few large round punctures; metasternum with anterior intercoxal piece not quite as broad as distance between hind margin of prosternum and hind margin of a fore coxae; posterior median fovea large and deep; with scales and large punctures around margins only, disk bare and shining. *Venter* with intercoxal piece of first ventrite almost triangular, the first two ventrites rather evenly set with large round setiferous punctures, with scales near base and sides; ventrites three and four almost impunctate; ventrite five rather evenly set with round setiferous punctures. Length, 2.2 mm.; breadth, 0.9 mm.

Viti Levu, Fiji. Holotype in Lea's collection in the South Australian Museum at Adelaide.

I have a specimen that differs rather markedly from the type of this species in the shape of the prothorax and the relative distance between the eyes and scrobes. However, in most respects, it is similar to this species, and I do not wish to describe it until I have additional material at hand. I believe it is a distinct species.

Genus VITICIS Lea, 1930

Head with interocular area concave, slightly narrower than interscrobal area at antennae; eyes lateral, well separated from prothorax, strongly convex. *Rostrum* with dorsal outline discontinuous with that of head, expanded from

base to apex on sides; epistome not delimited posteriorly by a sulcus; scrobes passing obliquely downward and touching apical margin of eye. *Antennae* with funicle 6-segmented, the first segment largest. *Prothorax* but slightly broader than long, base broader than apex. *Scutellum* visible. *Elytra* with prominent humeri, ten striate. *Sternum* with coxae well separated. *Legs* with femora dentate; all tibiae curved and all strongly mucronate at tip; tarsi only 3-segmented, the claw segment absent, the third segment broad and solid.

Genotype: *Viticis bidentatus* Lea.

The 6-segmented antennal funicle and abnormal tarsi together with the dentate femora make this genus the most aberrant of the Fijian Ottistirini. It is known only from Fiji.

Lea stated in his original description that the scutellum was absent. However, it is distinct and visible. In his generic description he made the statement "femora bidentate." On his holotype of the genotype there are three teeth on the fore and mid tibiae, and evidently but one on the hind tibiae. In addition to the large tooth at about the basal third, there is a small tooth on either side of the median line at about the middle. The inner tooth is rather difficult to see and was overlooked by Lea. On his mutilated cotype the fore tibiae have four teeth, the middle pair three teeth, and the hind pair is bidentate.

3. **Viticis bidentatus** Lea (fig. 1, *g*).

Viticis bidentatus Lea: Linn. Soc. N. S. Wales, Proc., **55**:464, 1930.

Derm shining black with the antennae yellowish brown, rather loosely clothed with round yellowish scales with an iridescent luster.

Head deeply concave between eyes, with a small, irregular, asperate callosity above each eye; eyes situated at base of rostrum and distant from apex of prothorax; with scattered punctures and elongate, prostrate scales and squamiform setae. *Rostrum* slightly broader than long; apex rounded and sinuous at middle; dorsal outline angulate; rather closely punctate above and squamose only to slightly beyond antennae, rather densely squamose at sides along anterior margin of scrobes. *Antennae* with scape as long as funicle excluding club; first funicular segment subglobose, about as broad as long, as long as the two following segments together, second segment almost as long as three plus four, four to six subequal but successively broader; club elongate, twice as long as broad, as long as the funicle. *Prothorax* slightly broader than long, subcylindrical, but slightly expanded at middle; rather closely punctate, each puncture usually capped with a scale; apex slightly raised, base slightly sinuous. *Elytra* slightly emarginate in middle at base, gradually expanded on sides from the humeri to beyond middle where they are broadest, almost three times as long as prothorax (8:3); striae rather coarse, about half as broad as intervals, the punctures distinct, rather large and bearing fine setae; intervals convex; scales predominantly scattered, but condensed in patches to form a vague

fascia above declivity, and a patch on the fourth interval at about the basal fourth. *Legs* coarsely reticulate and rather closely punctate throughout; thinly clothed with prostrate, squamiform setae. *Sternum* with metasternum with scattered punctures especially at sides, with a post-median fovea. *Venter* with the first two ventrites with large scattered punctures; the others almost impunctate. Length, 2.2 mm; breadth, 1.1 mm.

Viti Levu, Fiji. Holotype in Lea's collection in the South Australian Museum at Adelaide.

This is an easily recognized species with the scaling not concealing the derm as in the other members of the tribe in Fiji.

Genus OTTINYCHUS Marshall, 1931

Head with interocular area usually at least twice as broad as interscrobal area rarely but one fourth broader. *Rostrum* with epistome not delimited posteriorly by a sulcus; scrobes passing downward nearer to eye than apex of rostrum. *Antennae* with funicle 7-segmented, the first two segments elongate. *Prothorax* slightly broader than long; base broader than apex; arcuate on sides and dorsum. *Scutellum* visible. *Elytra* ten striate, abruptly broader than prothorax, humeri prominent. *Sternum* with all coxae distinctly separated; metasternum with a post-median fovea. *Legs* with femora edentate; anterior tibiae nearly straight or slightly curved externally, lightly sinuous internally, mid and hind pairs straight internally and lightly sinuous externally; fore and mid pairs armed with a strong mucro at the inner apical angle, the hind pair unarmed; tarsi with third segment deeply bilobed, the fourth bearing a single claw.

Genotype: *Ottinychus buxtoni* Marshall [Insects of Samoa, 4 (5): pl. 253, 1931] holotype in the British Museum.

Among the Fijian Ottistirini this genus resembles *Leacis* more than the others. Like *Leacis, Ottinychus* has single tarsal claws, but the epistomal suture is indistinct, the epistome is not delimited posteriorly by a sulcus, and the interscrobal area is much narrower. Heretofore this genus contained two species and was known only from Samoa.

Key to Fijian Ottinychus

1. Interscrobal area only about one third as broad as interocular area; scaling above predominantly brown variegated with yellowish patches .... **O. comptus**
   Interscrobal area three fourths as broad as interocular area; scaling black and iridescent green or black and gray 2
2. Scaling above mostly black and variegated with iridescent green scales .... **O. gemmatus gemmatus**
   Scaling above black variegated with whitish or grayish scales, without green scaling .... **O. gemmatus griseus**

4. Ottinychus comptus, new species (fig. 1, *c*).

Derm reddish brown, eyes black, densely clothed above with chocolate-brown scales variegated with patches of yellowish scales; the scales iridescent; head and rostrum with yellowish scales, with a variable brown patch on crown that extends to between the eyes on one specimen; prothorax with a sub-Λ-shaped dark median area and with an interrupted yellowish median vitta, and a large pale area on each side of dark discal area; elytra with scattered, irregular patches of yellowish scales on chocolate-brown background; legs with dorsal and usually ventral parts of femora with yellowish scales, elsewhere with brown scales.

Head with derm concealed by scaling; interocular area broader than length of eye, the space between eye and prothorax more than half distance between eye and scrobe; eyes distinctly more convex than head, hardly more than half as broad as interocular area. *Rostrum* much broader than long and shorter than head, the dorsal outline continuous with that of forehead in basal half and steeply and irregularly declivitous in apical half which is devoid of scales, coarsely reticulate and bearing a few setiferous punctures; apical margin emarginate at middle, dorsal part of scrobe slightly longer than distance between eyes and descending part of scrobe which passes eye at a distance equal to about half that between eye and dorsal angle of rostral declivity. *Antennae* with scape as long as first six funicular segments; the first funicular segment three fourths as broad as long, as long as two plus three and twice as broad as two, two as long as three plus four, three to seven becoming successively broader; club as long as the preceding six segments. *Prothorax* broader than long (3.0 :2.5), almost evenly expanded on sides from base and apex to middle; base slightly sinuous; longitudinal dorsal outline rather evenly convex but slightly impressed before apex; derm concealed by dense scaling, rather closely punctate, punctures bearing fine recumbent setae. *Scutellum* very small, pointed, covered with dark scaling. *Elytra* about three fourths as broad as long and about three times as long as prothorax, broadest at prominent, angulate humeri, subparallel-sided to subapical constriction; striae deep and distinct, their punctures bearing minute setae; intervals about twice as broad as striae and each bearing a row of minute setae. *Legs* with femora rather densely squamose and setose, mid and hind tibiae not so densely squamose. *Sternum* with but few scales, rather closely set with setiferous punctures. *Venter* with first two ventrites convex, suture between them strongly angulate, rather evenly set with setiferous punctures; ventrites three and four evidently impunctate and with a single line of setae; ventrite five with a few setiferous punctures. Length (including head and rostrum), 1.9-2 mm.; breadth, 0.8 mm.

Viti Levu, Fiji. Holotype male to be deposited in the South Australian Museum, and one female paratype stored in Bishop Museum. Both of these specimens were collected by Lea and were designated by him as cotypes of *Leacis* (*Eutinophaea*) *vitiensis* (Linn. Soc. N. S. Wales, Proc., **55**: 462, 1930).

This is the smallest species of the genus known to me. The structure of the rostrum and color pattern readily distinguish it. It varies from the genotype in having the suture between the first and second ventrites angulate instead of straight.

5. Ottinychus gemmatus, new species (fig. 1, *a-b*).

Derm black with appendages reddish brown, densely clothed above with almost black scales with coppery reflections and variegated with patches of iridescent green scales; crown of head with dark scales, head and rostrum otherwise with green scales; pronotum with a variable, narrow, green median vitta, bounded on each side by a broad, black vitta, broadest in basal half, each vitta with a lateral branch beyond the middle which together form a common transverse fascia, the black area thus formed cross-shaped, prothorax elsewhere with green scaling; elytra variegated with variable irregular patches of green scales on black background; legs with paler green scales.

Head with derm concealed by scaling; with setiferous punctures discernible; interocular area one and a half times as broad as eye, less than one fourth broader than interscrobal area; space between eye and prothorax somewhat less than half the length of dorsal part of scrobe, and about twice as broad as downward part of scrobe before eye; eyes more convex than head. *Rostrum* forming a broad angle with head, about twice as broad as long without mandibles, dorsal outline rather evenly convex longitudinally and without any abrupt changes or irregularities in its contour, squamose to epistome which is bare and shining, with a few slender setae, slightly emarginate in middle, point of junction of epistome with squamose part of rostrum marked by a vague line between anterior ends of dorsal parts of scrobes; scrobes passing downward from their dorsal parts in a straight, oblique line, distance between scrobe and eye somewhat less than breadth of scrobe. *Antennae* with scape about as long as first six funicular segments; first funicular segment not quite as long as two plus three, three fourths as broad as long and about twice as broad as the second, two as long as three plus four, three to seven successively broader; club as long as the preceding six segments. *Prothorax* distinctly broader than long (4.0:3.25), broadest somewhat beyond middle, base slightly convex, rather evenly arcuate on sides, but expanded almost straight from base to middle, longitudinal dorsal outline slightly convex, almost flat in basal half; derm concealed by scaling, but with rather close punctures bearing slender recumbent setae showing through. *Scutellum* small, pointed, and covered with black scales. *Elytra* broadest at prominent humeri and there five eighths as broad as long, five eighths as long as prothorax (8:3) roundly narrowing on sides to apex but with a rather strong subapical constriction; longitudinal dorsal outline sloping straightly, gradually, and slightly upward from base to reach its summit at top of declivity; striae well marked, punctures distinct and bearing fine recumbent setae; the first interval about half as broad as second at base, the others two or three times as broad as striae and each bearing a row of minute recumbent setae. *Legs* mostly densely squamose. *Sternum* with few scales except at sides; metasternum with a row of large punctures along fore margin, almost impunctate in middle except for median fovea. *Venter* with intercoxal piece strongly angulate, first ventrite with a row of large setiferous punctures along the basal and apical margins, with scattered punctures at sides, one and a half times as long as second, suture between them straight, fused in middle; two as long as three plus four, slightly shorter than five, with a few large punctures; three and four evidently impunctate, five rather closely and finely punctate and with numerous setae. Length, 2 mm. (excluding head and rostrum); breadth, 1 mm.

Viti Levu, Fiji. Holotype, evidently a female, collected by F. Muir at Rewa, March 1906, to be deposited in the British Museum, and a paratype collected by W. Greenwood in the mountains, Lautoka, February 4, 1920, stored in Bishop Museum. These specimens were sent to me from the British Museum through the courtesy of Sir Guy Marshall.

The paratype is evidently an older specimen than the holotype and has the black cross on the prothorax indistinct and the green scales on the prothorax grayer and not so brilliant as those of the holotype.

This is a rather puzzling species, which I first thought might represent a new genus. On other species of *Ottinychus* the interscrobal area is only half or less than half as broad as the interocular area. On this species, however, the interscrobal area is somewhat more than three fourths as broad as the interocular area. On other species of *Ottinychus* the declivitous apical part of the rostrum is bare and continuous from above the insertion of the antennae to the apex of the rostrum, whereas on this species the epistome only is bare and is distinctly separated from the basal squamose part of the rostrum; the area above the epistome is squamose continuously with the base of the rostrum. These structural characteristics give the head and rostrum of this species a rather different facies than the other species of the genus. If, when additional collections are made, the breadth of the interscrobal area is shown to be a constant character used to separate a group of allied species from typical species of *Ottinychus,* it may be worthwhile to erect a new subgenus or genus for this species and its allies. At present I cannot find other characters to substantiate the separation of this species from *Ottinychus,* and I believe that it should remain in *Ottinychus* unless new data are assembled whereby it may be separated.

5a. Ottinychus gemmatus griseus, new subspecies.

This subspecies is similar in structure to the typical form, but it lacks the green scaling so characteristic of the type. The green scaling is replaced entirely by white or grayish scales, which, together with black scaling, give the subspecies a dark gray appearance. The arrangement of the dark and pale scales is similar to that of the typical form.

Ovalau, Fiji. Holotype, presumably a female, collected by W. Greenwood, May 4, 1922, to be deposited in the British Museum whence it was sent to me for study by Sir Guy Marshall.

The posterior line of demarcation of the epistome is more pronounced in this specimen than in the types of the typical form. Under high magnification it appears to be a shallow and distinct suture.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV | January 30, 1939 | Number 16

A New Species of Byttneria from Mangareva[1]

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The material on which the following description is based was submitted to me for identification by E. H. Bryan, Jr., Curator of Collections, Bernice P. Bishop Museum. The two collections, one in flower, the other in fruit, apparently represent a hitherto undescribed species.

Byttneria oligacantha Merrill, sp. nov. (fig. 1).

Herba suffruticosa, erecta vel suberecta, plus minusve ramosa, usque ad 2 m. alta e basi incrassata lignosa, caulibus 5-7 mm. diametro, deorsum teretibus, sursum plus minusve subangulatis, subsulcatis, vel striatis, aculeis paucis remotis e basi incrassata circiter 2 mm. longis armatis, partibus superioribus inermis vel subinermis, ramulis ultimis circiter 1 mm. diametro, glabris vel uno latere plus minusve pubescentibus; foliis chartaceis vel submembranaceis, in caulibus primariis ovatis, 8-12 cm. longis, 6-9 cm. latis, basi rotundatis vel obscurissime late cordatis, apice acuminatis, 5-nerviis, in ramis ultimis minoribus, 4-9 cm. longis, 2-5 cm. latis, majoribus irregulariter serrato-dentatis vel serrato-crenatis, minoribus obscurissime dentatis subintegris vel integris, subtus conspersissime pubescentibus; nervis primariis utrinque 4-6, distinctis, curvato-adscendentibus, anastomosantibus; petiolis in foliis majoribus usque ad 5 cm. longis, consperse minuteque aculeatis, in foliis minoribus inermibus, plus minusve pubescentibus, 4-8 mm. longis; inflorescentiis paucifloris, plerumque axillaribus, in ramulis ultimis, petiolum subaequantibus vel eo paullo longioribus, plerumque vix 1 cm. longis, rariter usque ad 2 cm. longis; floribus 6-7 mm. diametro, calycibus membranaceis, glabris, lobis triangulari-ovatis, acuminatis, circiter 2.5 mm. longis; petalis usque ad 4.5 mm. longis, supra basin incrassato-subcucullatis, cuculla obscure 2-lobata, circiter 1 mm. diametro, supra in ligulam elongatam simplicem producta, ligula plus minusve incrassata linearia vel claviformia, circiter 3 mm. longa; staminoides circiter 1 mm. diametro, apice subtruncatis

[1] Mangarevan Expedition Publication 29.

apiculatisque; staminibus 5; ovario subgloboso, vix 0.5 mm. diametro, obscure muricato; capsulis 5-locularibus, globosis, immaturis cum spinis usque ad 1.5 cm. diametro, spinis deorsum incrassatis patulis, rectis vel leviter curvatis, glabris, 3-8 mm. longis.

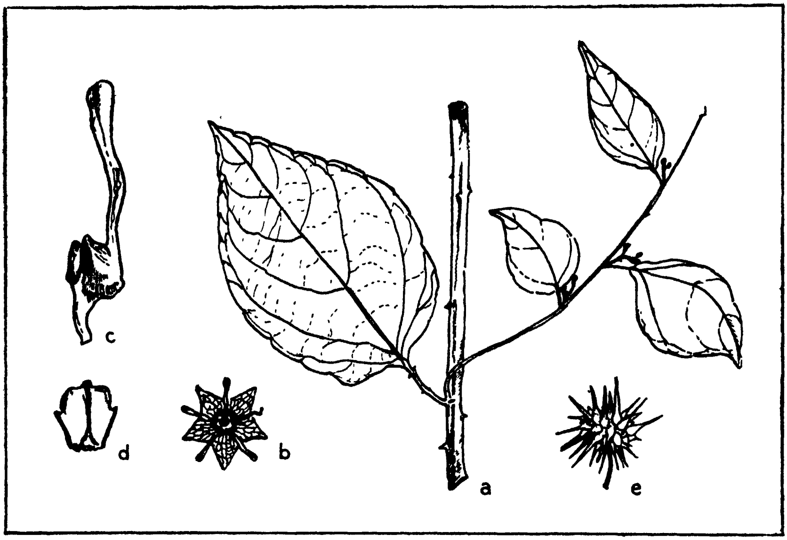

FIGURE 1.—*Byttneria oligacantha* Merrill: *a,* leafy branch (somewhat enlarged); *b,* flower (× 2); *c,* petal, lateral view (× 5); *d,* staminode (× 9); *e,* immature fruit (natural size).

Mangareva, northeast side of Mount Duff, in upper part of small wooded area, alt. about 120 m., suffrutescent herb about 2 m. high with several erect stems from a woody base, flowering, June 23, 1934, *H. St. John 14450* (type); Gatavake Valley, base of Mount Duff, in moist forest, alt. about 100 m., sprawling herb with green globose fruits, June 26, 1934, *F. R. Fosberg 11355.* Native name: *tutu taratara.*

This is the second species of the genus to be recorded from Polynesia, and from a phytogeographical standpoint one might expect its closest alliance to be with *Byttneria tahitensis* Naud. (Enum. Pl. Tahit., 68, 1873, type from Tahiti) which is beautifully illustrated by Drake del Castillo (Ill. Ins. Maris Pac., 33, t. 11, 12. 1886), and of which there is an authentic specimen in the Gray Herbarium. However, it differs not only in all details of floral structure, but also in habit, vegetative characters, inflorescences, fruits, and in being more

or less aculeate, not smooth. In facies, and doubtless in its botanical alliances, it seems to be much closer to certain tropical American species, notably *Byttneria aculeata* Jacq., *B. carthaginensis* Jacq., *B. acuminata* Bred., and *B. urticifolia* K. Schum., which are characterized by being more or less herbaceous, erect or scandent, and aculeate.

The holotype is deposited in the herbarium of the Arnold Arboretum; an isotype is preserved in the herbarium of Bishop Museum. The original spelling of the generic name is accepted as correct (Sprague, Kew Bull., 42, 1929). Variants are *Bytneria, Büttneria, Buttneria, Bütneria, Buettnera,* and *Buettneria,* the latter being the most generally accepted form.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

Volume XIV March 1, 1939 Number 17

The Genus Phanerostethus in Fiji
(Coleoptera, Curculionidae)

By ELWOOD C. ZIMMERMAN

The cryptorhynchine genus *Phanerostethus* was erected by Sir Guy A. K. Marshall in 1931 [Insects of Samoa, 4 (5) : 285] for the reception of a new species from Samoa. I recently described two new species from the Society Islands [B. P. Bishop Mus., Occ. Papers, 12 (23), 1936]. In this paper I describe two new species from Fiji, the fourth and fifth known species of the genus. Knowledge of the existence of this genus in Fiji is important to discussions of zoogeography in Oceania, for it makes one more link in the chain of distribution of Pacific insects.

The genus may be characterized briefly as follows: funicle of the antennae seven-segmented, the first two segments elongate; base of the pronotum higher than the apex and with the dorsal contours of the elytra and pronotum rather abruptly discontinuous at their point of junction; scutellum distinct, though small; elytra subtruncate at the base and there not broader than the base of the prothorax; without humeral calli; wings not functional; legs with the femora edentate; the pectoral channel squamose and the mesosternal receptacle with high side walls but open behind; ventrites all free, the sutures between them all distinct; body densely squamose both above and below.

Key to the Fijian species

1. Ground color of the dorsal scaling black, with only a few patches of pale scales; prothorax about as long as broad; second elytral interval with only a double row of setae and without distinct fascicles........ ....**P. vitiensis.**

2. Ground color of dorsal scaling brown, variegated with numerous patches of pale scales; prothorax much broader than long; elytral interval two expanded before and behind the middle and there conspicuously fasciculate .... **P. fasciculatus.**

1. **Phanerostethus vitiensis,** new species (fig. 1, *a, b*).

Derm black, with antennae and tarsi reddish; scaling above predominantly black with a few patches of yellowish scales; scales on head mainly black and very dense; pronotum with black scales and a conspicuous patch of yellowish scales at base before scutellum and usually with a patch of two or three yellowish scales on each side of disk just behind middle; elytra with black scales and with scattered patches of yellowish scales; legs with bases of femora and apices of tibiae usually with pale or white scales, otherwise with black scales; scaling on venter much paler, predominantly gray.

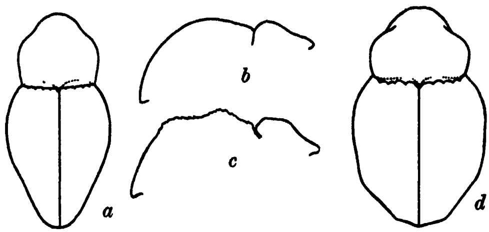

FIGURE 1.—Outline of new *Phanerostethus: a, b, P. vitiensis; c, d, P. fasciculatus.*

Head with punctuation hidden by dense scaling which is arranged somewhat like honeycomb, with numerous short, erect, white setae. *Rostrum* in male finely carinate on dorsum almost to antennae; female with carinae wanting and basal squamose and setose area not extending nearly to antennae as in the male; rostrum on both sexes otherwise shining, that of male finely and densely punctate, that of female reticulate. *Antennae* with first funicular segment stouter and but slightly longer than second, two as long as three plus four, three longer than four, segments three to seven becoming successively shorter and broader; club hardly longer than three preceding segments. *Prothorax* approximately as broad as long or slightly longer than broad; rather straightly expanded on sides from base to rounded middle, subapical constriction rather prominent and continued broadly and conspicuously across dorsum; base truncate, steeply and abruptly rising above level of base of elytra, reaching its highest point at about the basal fourth and there slightly higher than the highest point on the elytra; punctuation coarse and very close, punctures large and angular, interstices between them narrow and sharp; each puncture usually bearing a short erect, spatulate seta; pale scales before scutellum large and concave. *Elytra* subtruncate at base, about three fourths as broad as long; vaguely subcordate, but with apices jointly and broadly rounded, without subapical calli; intervals mostly rather narrow, their punctures largest near base, the tenth not reaching hind coxa, six and seven terminating at a distance from base of elytra; first interval flat, others conspicuously convex, first five intervals somewhat tuberculiform at

their basal extremities, fifth rather steep on its outer edge near base; the first interval with a few, scattered, erect setae, intervals two and four bristling with closely placed setae, other intervals on disk with fewer setae, intervals on sides with few setae. *Legs* with numerous, short, erect setae, those on femora mostly white and outstanding against dense black scaling. *Sternum* with pectoral canal squamose in its prosternal part, bare between fore coxae and in mesosternum; mesosternal receptacle with high side walls that project forward to fore coxae, terminating at about middle of mesocoxae in the male and almost at their posterior margins in the female; metasternum short, concave in both sexes, densely squamose. *Venter* densely squamose and with short, prostrate, squamiform setae; first ventrite very broadly and conspicuously concave throughout its length in the male, with scaling long and more or less fasciculate at margins and apex of median excavated area; the female with first ventrite slightly, transversely impressed at base, otherwise slightly convex, scales oval and not tending to be elongate and more or less hairlike and not fasciculate; first ventrite on a lower plane than last three, second sloping upward to join third. Length, 2.6-3.5 mm.; breadth, 1.2-1.8 mm.

Fiji: Viti Levu, Vanua Levu, Taveuni, Ovalau, Matuku, Moala, and Tuvutha Islands. Holotype female and allotype male, stored in Bernice P. Bishop Museum, and ten other specimens from Tholo-i-Suva, Viti Levu, June 29, 1924; one specimen from Matuku Island, July 3, 1924; one from Moala Island, July 13, 1924, and one taken from "Yangasa cluster" Tuvutha, Lau, August 11, 1924, all collected by E. H. Bryan, Jr. Seventeen specimens collected at Waiyevo, Taveuni, in February, March, October, 1924, and November 1923; four specimens collected at "Lovonivonu," June 7, 1924, and two from Kubulau and Davalevu, Vanua Levu, May 1924, all by H. S. Evans. One specimen from Ovalau, June 24, 1927, collected by H. W. Simmonds. One specimen collected by F. Muir in January 1906, and one labeled "Fiji" collected by A. Koebele. All the specimens collected by Evans and Simmonds were sent to me for study from the British Museum, through the kindness of Sir Guy A. K. Marshall.

This species is most closely allied to *Phanerostethus dilophus* Marshall from Samoa, but it is very distinct from that species. On the Samoan species the alternate intervals are elevated and somewhat tuberculate and there is a callosity at the top of the declivity on interval three. These and many other characters disagree with this new Fijian species, which is the only known species on which the scaling is predominantly and outstandingly black.

2. **Phanerostethus fasciculatus,** new species (fig. 1, *c, d*).

Derm piceous to black; scaling subject to considerable variation, that above basically dark brown, variegated with variable pale spots; head with an almost white longitudinal median stripe on crown between lateral patches of brown

scales, forehead with pale scales, often the entire front of head with pale scaling or without the vitta on crown; rostral scaling brown; prothorax with dark brown scales with a complete or broken longitudinal vitta of pale yellowish brown scales from base to apex, this line either expanded before middle to form a rough diamond-shaped pale patch or with a patch of pale scales on either side before middle to form a rough cross, usually, but not always, with an irregular band or series of patches of pale scales beginning at base before elytral interval five and running forward to lateral constriction, then turning inward toward the median vitta; basic elytral scaling similar to that on the pronotum, dark brown or almost black, variegated with patches of yellowish brown or almost white scales, lateral half of posterior calli on interval two pale, intervals seven and eight almost always with a conspicuous patch of white scales above the suture between ventrites one and two that is the most outstanding mark on the dorsum and easily seen with unaided eyes, this lateral patch usually connected with the pale, posterior part of the posterior fascicle on the second interval with an irregular band of pale brown scales; scaling below pale to dark brown; femora with dark brown scales and usually paler scales near base and a pale subapical band; tibiae dark brown with paler scales and setae on the distal half.

Head with the derm and punctuation entirely hidden by very dense scaling; scales depressed and not tending to be arranged like honeycomb; with erect spatulate setae forming a single row along inner margins of eyes and a few scattered between eyes, otherwise without distinct setae; interocular area with a conspicuous, rather long, narrow, deeply impressed, longitudinal median sulcus. *Rostrum* with little or no scaling at the base but with lines of rather dense erect spatulate setae, setose almost to antennae in male, only half so far in the female; male with a well-developed median carina from near base almost to antennae, and with two finer, irregular carinae on either side, female with carinae much finer and less developed; shiny, densely and minutely punctate beyond antennae in both sexes. *Antennae* with scape as long as first four funicular segments; first funicular segment one sixth longer than second and one third broader at apex, second segment as long as two plus half of three, three and four equal, five almost as long as four and slightly longer than six, seven somewhat shorter than six and transverse; club as long as preceding four segments together. *Prothorax* distinctly transverse (as 8:6 or 7:5), strongly rounded on sides in basal two thirds, then strongly and angulately constricted, basal two thirds strongly gibbose, rising far above the base of the elytra, reaching its highest point in basal third and there no higher than the highest part of the elytra; subapical constriction strongly marked, deeply, broadly, prominently continued across the dorsum; sculpture almost entirely concealed by dense scaling; coarsely, deeply and densely punctate throughout, punctures moderately large, rounded, their interstices narrower than their diameters, each puncture usually bearing a stout, erect, clavate or spatulate seta that rises well above the scaling. *Scutellum* very small, often hardly discernible. *Elytra* but slightly longer than broad (6.5:5.5), base slightly sinuous, emarginate at each stria and therefore conspicuously crenulate from suture to humeri; humeri rather sharp and slightly embracing baso-lateral prothoracic angles, lateral outline thence rather angulately expanded for about one sixth the length, thence broadly rounded to apex; longitudinal dorsal outline strongly convex throughout, excepting for an inconspicuous depression behind the scutellum, outline interrupted by the fascicles on the second interval; striae well impressed, conspicuous

throughout, their punctures deep, rounded, broader than striae, tenth stria discernible only at the apex, and feeble there, ninth stria joining second, eighth joining third and therefore enclosing fourth to seventh at apical fifth; intervals slightly convex, at least twice as broad as strial punctures on disk, derm concealed by very dense scaling, usually with a single row of stout, erect spatulate setae, second interval expanded before and just behind middle and there with conspicuous fascicles of erect scales and setae, fourth interval with similarly placed but much less developed and inconspicuous loose fascicles consisting mainly of condensed setae. *Legs* densely squamose and setose; femora not strongly clavate, edentate; tibiae with some fine hair below; first hind tarsal segment as long as two plus three plus half of four, two only very slightly longer than broad, hardly longer than three, three deeply bilobed, almost twice as broad as long, four as long as two plus three. *Sternum* with anterior half of sides of mesosternal receptacle strongly produced into very conspicuous anteriorly inclined processes that reach a level lower than most ventral part of mesocoxae; metasternum at its narrowest point between mid and hind coxae only one fifth as broad as a metacoxa. *Venter* with the intercoxal process broadly arcuate, twice as broad as a metacoxa; first ventrite flattened in male, hardly more convex in female, posterior margin broadly concave in middle third; entire venter very densely clothed with ovate scales that conceal the derm; ventrites one and two coarsely punctate near their bases, venter elsewhere inconspicuously finely or minutely punctate and coarsely reticulate. Length, 3.5-4.5 mm.; breadth, 2.0-2.75 mm.

Fiji, Tuvutha Island, Lau Province. Holotype male, allotype female, stored in Bernice P. Bishop Museum, and 16 paratypes collected by E. H. Bryan, Jr., September 10 and 11, 1924. This species is widely spread in Fiji. There is a good series of specimens in the British Museum from several other localities in Fiji.

Because of its broad form and coloration this species is very distinct from any of the other described members of the genus.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV March 6, 1939 Number 18

Cypraeidae from Makatea Island, Tuamotu Archipelago

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Makatea Island, sometimes referred to as Aurora Island, is situated in the Tuamotu Archipelago in 14° 54′ South Latitude and 148° 13′ West Longitude. Unlike most of the 78 islands in this group it is not an atoll; formerly one, it has been raised by upheaval of the earth's crust. The highest peak on the island, Mount Putiare, is 358 feet above sea level. The island is about 5 miles long, lying east and west. A fringing reef borders all but the eastern side. The growth of the reef has been most prolific on the northern shore where it extends in some localities 500 feet to seaward. Thus a very favorable habitat is available to the cowries in the reef waters about Makatea. During low tide much of the reef platform is exposed, and mollusks may be found in abundance in the tide pools (Alvin Seale, Director of Steinhart Aquarium in San Francisco, personal communication).

The data included here are based upon material gathered by Alvin Seale in 1902 and stored in Bernice P. Bishop Museum, Honolulu, and upon specimens in my own collection.

Of the 24 species represented in the collections seven are fairly abundant. Apparently the most common species is *Cypraea arenosa* Gray, which seems to be found in greater numbers in the Tuamotus than in any other island group. Likewise *C. scurra* Chemnitz and *C. irrorata* Solander seem to have found there the best environment for production of individuals. Other common species are *C. isabella* Linnaeus, *C. helvola* Linnaeus, *C. carneola* Linnaeus, and *C. intermedia* Gray.

Several of the cowries listed here are used by the natives for ornamental purposes. *C. irrorata* Solander, *C. arenosa* Gray, and *C. moneta* Linnaeus are strung on wire, cloth, or fiber to be worn as beads or as hatbands. The shells used in such strings are usually beach-worn. Frequently there are as many as 500 shells in a single strand of beads.

The purpose of this paper is to further the work begun by the writer in making clear the distribution of the Cypraeidae in the Pacific Ocean,[1] and to present information concerning the use of cowries by native islanders.

Listed Species

Cypraea arenosa Gray, Zool. Jour., 1:147, pls. 7, 12, fig. 6, 1824.
This is the most common species in the collections. A large specimen is 35 mm. long.

Cypraea caput-serpentis Linnaeus, Syst. Nat., 1175, 1767.
The shells are light brown; the marginal filling is extremely broad. The anterior and posterior canal extremities are generally marked with a dull orange-brown blotch.

Cypraea carneola Linnaeus, Syst. Nat., 1174, 1767.
The shells are elongate; none approaches the so-called variety *propinqua* Garr. The largest specimen is 78 mm. long.

Cypraea cicercula Linnaeus, Syst. Nat., 1181, 1767.

Cypraea helvola Linnaeus, Syst. Nat., 1180, 1767.
This is the typical South Seas form with broad orange marginal fillings and purple blotches on the dorsal surface of the anterior and posterior canal extremities. The largest specimen is 24 mm. long.

Cypraea goodali Gray, Desc. Cat. Cyp., 10, 1832.
This rare cowry is represented by one specimen in my collection.

Cypraea intermedia Gray, Zool. Jour., 1:77, 1824.
The developmental stages of the shell from the small bulla to the adult are present in the collections. The marginal fillings and the reticulated dorsal color pattern are light brown.

Cypraea irrorata Solander, Zool. Jour., 4:80, 1828.
Most specimens are beach shells. The small size of this species apparently makes it difficult to find when concealed in the fissures in coral rock.

Cypraea isabella Linnaeus. Syst. Nat., 1177, 1767.
The dashes on the dorsal surface range in color from light brown to black. Several species approach the Hawaiian form in tnat the anterior and

[1] The family Cypraeidae in the Hawaiian islands: Nautilus, 50:77-82, 1937.
Cypraeidae from Christmas, Palmyra, Washington, Fanning Islands: Nautilus 51:1-4, 1937.

posterior dorsal canal extremities have a brownish black blotch over the orange dorsal canal extremities.

Cypraea lynx Linnaeus, Syst. Nat., 1176, 1767.
The ground color ranges from gray blue to brown.

Cypraea mauritiana Linnaeus, Syst. Nat., 1176, 1767.
The dorsal reticulated pattern is quite distinct. The dorsal anterior and posterior canal extremities are orange brown.

Cypraea margarita Solander, Zool. Jour., 4:87, 1828.

Cypraea moneta Linnaeus, Syst. Nat., 1178, 1767.
The shell color varies from deep orange to slate gray. The annular ring on the dorsal surface may or may not be present.

Cypraea nucleus Linnaeus, Syst. Nat., 1181, 1767.

Cypraea obvellata Lamarck, An. sans Vert., 7:401, 1822.
Some specimens of this species seem to intergrade with *C. annulus* Linnaeus.

Cypraea poraria Linnaeus, Syst. Nat., 1180, 1767.
The scarcity of specimens of this species apparently indicates that it is quite rare in the waters about Makatea.

Cypraea punctulata Gmelin, Syst. Nat., 3404, 1790.
The specimens in the collections are all immature.

Cypraea reticulata Martyn, Universal Conch., pl. 15, 1782.
The reticulated pattern on the dorsal surface is not always distinct. The individuals are small, mostly less than 60 mm. long.

Cypraea scurra Chemnitz, Conch. Cab., 10:103, pl. 144, fig. 1338, 1788.
The dorsal reticulated color pattern may or may not be perfectly formed. A large specimen is 38 mm. long.

Cypraea talpa Linnaeus, Syst. Nat., 1174, 1767.
The color of the marginal fillings varies from a light to a dark brown. A large individual is 78 mm. long.

Cypraea tigris Linnaeus, Syst. Nat., 1176, 1767.

Cypraea ventriculus Lamarck, An. du Mus., 16:452, 1810.
In all the specimens the dorsal color pattern is lacking where the mantle lobes unite. This imperfection in color may be a sign of shell immaturity.

Cypraea vitellus Linnaeus, Syst. Nat., 1176, 1767.
All the specimens are bulbous. The color pattern in the mature individuals is broken where the mantle lobes join on the dorsal surface leaving a band about 3 mm. wide which lacks the normal brown color.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV | March 6, 1939 | Number 19

Endemic Hawaiian Cowries

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Five of the 29 species of *Cypraea* reported from the Hawaiian islands are endemic forms[1]. These are *Cypraea sulcidentata* Gray, *C. semiplota* Mighels, *C. tesellata* Swainson, *C. madagascariensis* Gmelin, and *C. ostergaardi* Dall. The present literature is largely confined to a systematic discussion of these species. Little information is available concerning the individual variations in size and relative abundance[1,2]. Therefore, I present such information here. Data concerning the possible evolution of the endemic species are also discussed, and detailed systematic descriptions based on large series of individuals are given.

The endemic cowries are distributed throughout the whole of the Hawaiian archipelago, extending from the northernmost and westernmost islands, Kure (Ocean), Midway, and Pearl and Hermes Reef respectively, to the southern and easternmost island, Hawaii.

No endemic species, except *Cypraea semiplota* Mighels, are collected abundantly in the living state. There are restricted localities on the Waikiki Reef, Maile Point, Kaneohe Bay and Kupikipikio Point, Oahu; Seal and Grass Islets, Pearl and Hermes Reef; Lahaina Reef, Maui; and Midway Island where *C. semiplota* is known to occur in quantity. The next most prevalent species, although not common, is *Cypraea sulcidentata* Gray. A number of large and perfect specimens have been obtained from Pearl and Hermes Reef by Captain and Mrs. William G. Anderson and Mr. Alex Anderson of Honolulu.

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[1] Ingram, W. M., The family Cypraeidae in the Hawaiian islands: Nautilus, 50:77-82, 1937.

[2] Ostergaard, J. M., Fossil marine mollusks of Oahu: B. P. Bishop Mus., Bull. 51:1-32, 1928.

Mr. David Thaanum and Mr. Ted Dranga of Honolulu have collected series of individuals from Kaneohe Bay, Oahu, and from the reef at Lahaina, Maui. Individuals of these two species occur in moderate abundance as beach shells on the islands of Oahu and Kauai; in this state, however, most of them are fragmentary or very badly worn by the grinding action of the surf upon the reefs before they are washed on the beach.

Although *Cypraea madagascariensis* Gmelin is commonly found as a beach shell on a number of islands, the only live collection that I know of was taken from the Lahaina Reef, Maui, by Thaanum and Dranga. *C. tesellata* Swainson is likewise very rarely taken alive, the only authentic living collections, so far as I know, being those of W. G. and Alex Anderson from Pearl and Hermes Reef, and Thaanum from Hilo, Hawaii. *C. tesellata* is collected occasionally as a beach shell and I have specimens gathered from the beach at Paumalu, Oahu, that are almost perfectly preserved.

Cypraea ostergaardi Dall is the rarest of the endemic cowries; individuals have never been collected alive. Mr. Jens M. Ostergaard of the University of Hawaii was the discoverer of this cowry; he gathered the type specimen with four others from the Honolulu harbor dredgings of 1905 and 1915. Thirteen specimens have been found since Mr. Ostergaard's first collection; four individuals from Pearl and Hermes Reef, three of which belong to Dranga and one to Thaanum; and nine individuals from Honolulu Harbor in the possession of Mr. H. C. Alexander. This latter collector obtained his shells from the sand dredged from Honolulu Harbor and used to construct Sand Island situated in the harbor.

There is a great range in size between the largest and the smallest individuals of the endemic species measured here. In computing the shell size only fully mature specimens were employed; measurements were made along the dorsal-ventral, anterior-posterior, and basal axes at the points of greatest development.

The 18 individuals of *Cypraea sulcidentata* Gray that were measured exhibit the greatest range in size of the endemic species; generally any one mature individual of this species is larger than a mature individual of the other species. The largest shell measured approaches gigantism. This shell, now housed in Bernice P. Bishop Museum, Honolulu, was dredged from Honolulu Harbor, and is in excellent condition except that the dorsal coloration has bleached from the nor-

mal brown to a rich orange, much resembling that of *Cypraea aurantium* Martyn. The specimens measured of *C. madagascariensis* are of much more uniform size. The specimens taken from Honolulu harbor dredgings are as a group slightly larger than those taken in other parts of the archipelago.

Measurements in millimeters of five endemic species of Hawaiian cowries

Species	posterior anterior-	ventral dorsal-	basal
Cypraea sulcidentata			
average (18 specimens)	37.4	21.1	25.3
largest	69.0	39.0	39.0
smallest	29.4	16.0	19.0
Cypraea madagascariensis			
average (25 specimens)	27.6	11.7	17.8
largest	42.0	18.0	25.0
smallest	18.0	7.0	12.0
Cypraea tesellata			
average (11 specimens)	29.6	16.4	20.6
largest	34.0	18.0	23.0
smallest	17.0	12.0	9.0
Cypraea semiplota			
average (25 specimens)	15.9	6.7	9.0
largest	26.0	12.0	16.0
smallest	9.5	4.1	5.8
Cypraea ostergaardi			
average (5 specimens)	——	——	——
largest	20.0	——	——
smallest	14.0	——	——

The evolutionary descent of endemic forms is often an interesting problem. Mr. Jens M. Ostergaard has aptly discussed and has formed a hypothesis as to the immediate ancestors of the five endemic Hawaiian cowries.[8] I agree with his theories and cite them here, supplemented by additional observations.

There is but little doubt that *Cypraea tesellata* Swainson and *C. sulcidentata* Gray represent an evolutionary relationship to *C. arenosa* Gray. Ostergaard states, "The species *Cypraea arenosa* ap-

[8] Ostergaard, J. M., Fossil marine mollusks of Oahu: B. P. Bishop Mus., Bull. 51:1-32, 1928.

proaches *C. tesellata* in having shallow interstices between the teeth. In color pattern *C. arenosa* closely resembles *C. sulcidentata.* The relationship to *C. sulcidentata* is represented by a specimen of uncertain locality; the resemblance to *C. tesellata* by an abberant form recently dredged from Honolulu Harbor." I examined three specimens of *C. arenosa* from the Honolulu harbor dredgings that are very closely allied in general shell form as well as in coloring to specimens of *C. sulcidentata*; I also examined immature stages of both species and in some instances found it almost impossible to separate one from the other. Immature stages of *C. tesellata* that have been deposited by waves on the beaches about Oahu show close relationship to *C. arenosa* in the banding over the dorsal surface of the shell and in the dentition of the teeth lining the aperture. Ostergaard's conclusions are in accord with mine: "Owing to the very general distribution of *C. arenosa* and the local distribution of the other two species, it seems safe to infer that *C. tesellata* and *C. sulcidentata* are its modified offshoots."

Cypraea semiplota Mighels seems to have had a somewhat modified descent from *C. staphylea* Linnaeus. Although the latter species has never been collected alive or in the fossil state in the Hawaiian group, *C. semiplota* so closely resembles this species and its varieties, particularly var. *limacina* Mighels, that it seems likely that *C. semiplota* is the Hawaiian representative of *C. staphylea.*

Ostergaard writes: "*Cypraea madagascariensis* Gmelin (by some authors placed in the sub-genus *Pustularia,* comprising three recent species) is the endemic form of the genus that can be traced with certainty to the modified descent of *Cypraea nucleus* Linnaeus. Several fossils of this species from the limestone of Oahu show a marked approach to *C. nucleus*; although some recent specimens may also show its strong characters." I gathered two beach shells of *C. madagascariensis* from Sand Island in Honolulu Harbor which closely resemble specimens of *C. nucleus* Linnaeus that have been collected from the dredgings of Honolulu Harbor.

The closest relative of *Cypraea ostergaardi* Dall seems to be *C. helvola* Linnaeus, which is well established in the Hawaiian group and has been taken from various localities about Oahu in the fossil state. It seems safe to infer that *C. ostergaardi* Dall is a recent development from *C. helvola* Linnaeus that has not yet become established.

TAXONOMY OF THE ENDEMIC COWRIES

Cypraea semiplota Mighel, Boston Soc. Proc., **2**:24, 1848.
Cypraea polita Roberts, Am. Jour. Conch., **4**:70, pl. 15, figs. 1-3, 1868.
Cypraea annae Roberts, Am. Jour. Conch., **4**:250, pl. 15, figs. 4-6, 1868.

Shell obovate, sometimes nearly cylindrical; creamy orange to blackish brown; dorsal surface sprinkled with minute white spots; columellar side of aperture angled, sometimes heavy; teeth on columellar side at the anterior and posterior canal extremities extend toward the lateral margins of the shell across the base, teeth in columellar center sometimes extend a short distance over the base but are sometimes confined to the aperture; teeth and aperture tinged with orange yellow or brown, interstices between the teeth wide; aperture narrow, curved posteriorly; base ivory white or tumid; margin of shell at base fluted; anterior and posterior canal extremities brown or yellow brown.

The shells of this species from the Honolulu harbor dredgings are often bleached to an orange or yellow-orange color. Sometimes the minute white spots on the dorsal surface of a specimen that has been collected alive are destroyed by bleaching. The color of the canal, base, and extremities of shells dredged in the dead state from Honolulu Harbor is often obscured.

Cypraea ostergaardi Dall, Nautilus, 35: 50, 1921 (fig. 1).
Cypraea pacifica Ostergaard, Nautilus, **33**:92, 1920.

Shell whitish to cream colored to light brown, abundantly ornamented with chestnut brown spots, evenly sprinkled over the dorsal surface; base, aperture, and teeth white; lateral margins of shell elevated and pitted; teeth small and delicately cut, not confined to the aperture, and extending evenly over a narrow zone of the base. (Type specimen in the private collection of J. M. Ostergaard, Honolulu.)

When the late Dr. W. H. Dall reduced Mr. Ostergaard's species to synonomy he stated,[4] "I have had the opportunity of comparing a specimen [*Cypraea pacifica* Ostergaard] with the varieties of *C. Helvola* from the dump at Honolulu, to which it bears a suspicious resemblance, though apparently very distinct . . . I would suggest that this interesting form, whether variety or good species be named *ostergaardi* after its discoverer." Apparently Dr. Dall was not certain of the distinctness of this species from that of *Cypraea helvola* Linnaeus, and thought that it might prove to be only a variety. I have examined

[4] Dall, W. H., Nomenclature notes: Nautilus, 35:49-50, 1921.

15 of the 18 specimens known to exist, and although *C. helvola* is the nearest relative of *C. ostergaardi,* this species is certainly distinct enough in shell characters so that it could not be considered the same or even a variety.

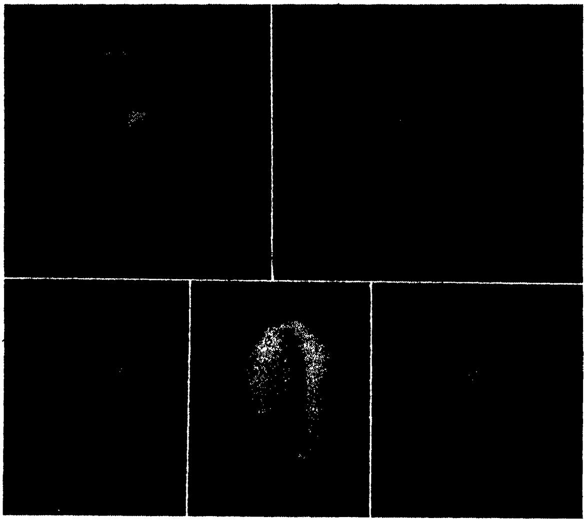

FIGURE 1.—*Cypraea ostergaardi* Dall: type specimen (lower right corner) and paratypes, about natural size (from photograph by C. H. Edmondson).

Cypraea tesellata Swainson, Zool. Jour., **1:** 150, 1824.

Shell squarely ovate; sides thickened; base angled upward toward lateral margins of shell; shell produced into distinct margins dorsally at anterior and posterior canal regions; extremities blunt; dorsal surface distinctly 3 banded with brown zones, color between zones light ash white to light brown; sides tesselated with light or dark brown square blotches, tesellations not always confined to the sides but sometimes found on dorsal-lateral portions of the shell, tesellations may be separated from base by irregular band of white or may be continuous with the color zonation of the base; base usually irregularly 3-banded with brown separated by white zones, the central brown band generally the broadest; teeth colored brown or orange brown; teeth usually extend for a short distance over the columellar and outer lip surfaces; teeth at the extreme anterior and posterior canal regions may or may not be confined to the aperture; teeth narrow.

The shells that have been gathered from the Honolulu harbor dredgings are usually bleached; sometimes the color zonation on the dorsal surface is obscured and the tesellations are much faded.

Cypraea sulcidentata Gray, Zool. Jour., 1: 148, 1824.

Shell ovate, sides and base thick; canal extremities blunt; sides are generally but slightly produced to form a narrow margin at the dorsal anterior and posterior canal extremities, though such a margin may be lacking in some specimens; dorsal surface ornamented with four distinct pale brown bands, these bands may be nearly equal but generally the most anterior one is the widest; sides brown, granulously arenaceous; base light brown; canal slightly curved anteriorly and posteriorly; teeth prominent, interstices quite deep, teeth generally extend over the outer lip surface of the base to nearly half its width, columella teeth are more extensive on this surface at the anterior and posterior canal extremities than at the columella center.

Dredged specimens from Honolulu Harbor are often bleached to a rich orange color; the dorsal banding is generally much faded and is sometimes entirely lacking, and the brownish color of the base is usually reduced to a smoky white.

Cypraea madagascariensis Gmelin, Syst. Nat., 3419, 1790.

Shell ovate, compressed dorso-ventrally; dorsal surface noduled, nodules prominent and connected with one another by irregular ridges; a dorsal groove is depressed upon the back of the shell running from posterior to anterior extremities; lateral margins usually produced; extremities obtuse; aperture narrow or mediumly so; teeth extend over the entire base and are prominent, teeth may or may not be continuous with the ridges connecting the nodules on the dorsal surface; interstices between the teeth broad; teeth may be alternately large and small, or equal; shell color creamy white, dorsal surface tinged with light brown or pinkish brown; lateral edges of teeth edged with orange brown.

Beach shells of this species often lack coloring due to bleaching by the sun.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV March 6, 1939 Number 20

Preliminary Revision of the Fijian Baridinae (Coleoptera, Curculionidae)

By ELWOOD C. ZIMMERMAN

INTRODUCTION

Little is known of the Baridinae of Fiji. To my knowledge, reference has been made to the Fijian members of the subfamily in only four papers. The first two papers were by Fairmaire (Pet. Nouv. Ent., **2**: 278, 1878; Soc. Ent. France, Ann., VI, **1**: 316-317, 1881) who listed two genera and two species. In 1931 Lea described five new species (Linn. Soc. N. S. Wales, Proc., **56**, 1931), and in 1936, I listed seven species recorded from Fiji [Bishop Mus. Occ. Papers **12** (3), 1936].

In this paper I have attempted to straighten out the confusion existing in the Fijian Baridinae. I have made no effort to describe the new species in the collections before me, although there are about twice as many new species as described species. I wish to express my thanks and appreciation to the South Australian Museum at Adelaide and its Director, Dr. Herbert M. Hale, for the privilege of studying Lea's types, without which this paper could not have been written.

Unfortunately, the Baridinae of Fiji were placed in a chaotic state by Lea's work. Not one of his five new species was placed in the correct genus and the two genera in which he located his species *Baris* and *Solenobaris* are not yet known to occur in Fiji. The numerous species he described from New Guinea (Linn. Soc. N. S. Wales, Proc., **56**: 139-171, 1931) should not be accepted as accurately placed until all the types are critically studied.

The Baridinae of the Pacific are a difficult group and have received little attention from taxonomists. The development of the subfamily in Papua and adjacent regions is surprisingly great, and perhaps even rivals that of tropical America. However, few of the species have been described.

Three of the five species described by Lea fit into no genus known to me, and I have been forced to erect three new genera to receive them. This is the only way in which I can present a discussion of the Fijian species to enable other workers to identify their material or ascertain the relationships of the fauna. The five Lean species form a most difficult assemblage of small forms. Analysis of the characters shows differences that must be taken as generic in value. Major difficulties encountered while working with the material are the facts that most of the specimens are partially dissected, that three of the species are represented by only the unique types, and that there are only two specimens of each of the other two species. In some specimens in which the elytra have been partially lifted from the abdomen the exact position of the pygidium as in life is rather difficult to ascertain.

List of Species

1. **Diorycaulus punctatellus** Fairmaire.
2. **Pseudocholus holocyanus** Fairmaire.
3. **Neosibariops nemorhina** (Lea), new genus, new combination.
4. **Heterobaris spathulirostris** (Lea), new genus, new combination.
5. **Nesobaris basipennis** (Lea), new combination.
6. **Nesobaris vitiensis** (Lea), new combination.
7. **Neoeremonyx nitidiventris** (Lea), new genus, new combination.

Key to the Genera

1. Prosternum not caniculate, at most shallowly impressed............................2
   Prosterum distinctly, longitudinally caniculate, with conspicuously elevated side walls............................4

2(1). Femora toothed below; first funicular segment slightly shorter than the second; head flattened between the eyes, but not separated from the rostrum by a distinct transverse groove; bluish species .... **Pseudocholus**

   Femora edentate; first antennal segment distinctly longer than the second; head separated from the rostrum by a distinct transverse groove; black species 3

3(2). Anterior, ventral margin of the prosternum with a deep and conspicuous median emargination; rostrum distinctly longer than the head and prothorax in both sexes, sometimes more than half as long as the body in the male and more than two thirds as long in the female; base of prothorax deeply bisinuate, base of elytra deeply trisinuate .... **Diorycaulus**

Anterior, ventral margin of prosternum truncate, without a median emargination; rostrum not longer than head and prothorax; base of prothorax and elytra not strongly sinuous........................ **Neosibariops**

4(1). Tarsi with single claws .... **Neoeremonyx**

Tarsi with two claws.. 5

5(4). Pygidium distinctly and rather broadly exposed from above............ .... **Heterobaris**

Pygidium concealed or but very narrowly exposed from above........ .... **Nesobaris**

Genus DIORYCAULUS Fairmaire, 1878

Head separated from the rostrum by a transverse depression; the interocular area as broad as the base of the rostrum. *Rostrum* long and slender, distinctly longer than the head and prothorax in both sexes, subcylindrical, slightly curved, almost straight in the female, the diameter subequal from base to apex, not narrowed or expanded; antennae inserted beyond the middle in both sexes; mandibles bidentate and decussate. *Antennae* with the scape slender, not reaching the eye, about as long as the funicle plus one half of the club; funicle 7-segmented, the first segment about as long as two plus three, two longer than three, segments four to seven submoniliform, seven distinctly separated from the club; club as long as the four preceding segments, elongate oval, 4-segmented, densely pilose throughout. *Prothorax* broader than long, subtriangular, base deeply bisinuate, the apical margin slightly angulate on the sides. *Legs* without long setae on the trochanters; femora not grooved, edentate; tibiae carinate, with a small angulation at the outer apical angle and with the inner apical angle produced into a prominent uncus; tarsi with the second segment transverse, the third broad and deeply bilobed, the fourth slender, the claws small and separated. *Sternum* with the prosternum with a distinct emargination in the apical margin, at most feebly impressed and not caniculate, the coxae separated by more than one and one half times their diameters, the median postcoxal piece on a line with the fore margins of the mesocoxae. *Pygidium* slightly exposed from above in the male, hidden in the female.

Genotype: *Diorycaulus punctatellus* Fairmaire.

Diorycaulus is closely allied to *Myctides* Pascoe, 1876; in fact, *Diorycaulus punctatellus* and *Myctides barbatus* appear, at first sight, to be very closely allied species. *Diorycaulus* may be separated from *Myctides* as follows: on *Diorycaulus* the rostrum is considerably longer and much more distinctly separated from the head, the antennae are inserted beyond the middle of the rostrum in both sexes, whereas

on *Myctides* they are inserted behind the middle and the scape is not longer than the funicle; on *Diorycaulus* the femora are neither grooved nor dentate, whereas on *Myctides* they are shallowly grooved and distinctly toothed; the tibiae on *Diorycaulus* are usually armed on the outer side with a small denticle or angulation, and the inner apical angle bears a long uncus; on *Myctides,* however, there is no denticle on the outer apical angle, the terminal uncus arises from about the middle of the apex and the inner apical corner is strongly angulate or it may bear a small tooth.

1. **Diorycaulus punctatellus** Fairmaire: Pet. Nouv. Ent., 282, 1878; Soc. Ent. France, Ann., 317, 1881.

This is the most distinct and easily recognized of the Fijian Baridinae in the collections before me. The following brief synopsis, in addition to the generic description, will serve to distinguish this large species:

Black throughout, rostrum coarsely punctate in both sexes; prothorax densely set with rounded punctures on the disk, becoming confluent on the sides; elytra with rather coarse striae, the intervals with rather coarse transverse punctures that give the intervals a more or less transversely plicated appearance, the punctures setigerous, the alternate intervals with an occasional seta expanded into a small, flattened, prostrate, white squamule; legs, pleural and ventral surfaces densely punctate, the punctures bearing small, but conspicuous, white setae or squamiform setae; tibiae with a long, prominent hair pencil before the inner apical angle, giving the appearance of two apical tibial unci. Length, 5-6 mm., excluding the head and rostrum.

Among the five specimens before me are two from *Eugenia* seeds collected by Koebele at Suva, Viti Levu, Fiji, and one from Mango Island in the Lau group of Fiji, collected by E. H. Bryan, Jr., Sept. 17, 1924.

Genus PSEUDOCHOLUS Lacordaire, 1866

2. **Pseudocholus holocyanus** Fairmaire: Pet. Nouv. Ent., 282, 1878; Ent. Soc. France, Ann., 317, 1881.

This is a rather shiny blue species with white pubescence on the middle of the prosternum and sides of the metasternum. According to the description, it is a very distinct species and should be easily recognized when seen. I have not seen this species.

Genus NEOSIBARIOPS, new genus

Head separated from the rostrum by a transverse groove; interocular area as broad as the base of the rostrum. *Rostrum* rather long and slender, slightly longer than the prothorax, subcylindrical, arcuate, slightly compressed in the basal half, slightly expanded and depressed at the apex; mandibles bidentate and decussate; antennae inserted before the middle (at the basal two fifths measuring along the ventral margin). *Antennae* with the scape slender, almost touching the lower margin of the eye, about as long as the funicle excluding the club; first funicular segment as long as two plus three, two as long as three plus four, three to seven successively more transverse, seven distinct from the club; club as long as the preceding four segments, 4-segmented, finely pilose throughout. *Prothorax* broader than long, base with a median, prescutellar lobe, but otherwise subtruncate, dorsally and laterally truncate at the apex. *Legs* with the femora not grooved, edentate; tibiae not carinate, slightly expanded distally, the outer apical angle rounded, without an uncus, the inner apical angle bearing a strong uncus; tarsi with the second segment transverse, the third with broad lobes, the fourth rather stout and about twice as long as the third, the claws free and divergent. *Sternum* with the prosternum rather narrowly, transversely impressed, not at all longitudinally impressed, the apical margin entire; fore coxae separated by more than half the breadth of a coxa; the median post coxal piece terminating between the fore and mid coxae, not produced backward; metasternum only one half as long between the mid and hind coxae as its episternum. *Venter* with the first two ventrites fused, the fifth as long as three plus four. *Pygidium* oblique, but approaching vertical and moderately exposed from above.

Genotype: *Baris nemorhina* Lea.

The genotype of this genus so closely resembles some of the North American species of so-called *Limnobaris* and its derivatives, especially *Sibariops,* that I almost question its having come from Fiji. One of the major characters, used in America to separate *Limnobaris* and closely allied derivatives from other genera, is the length of the metasternum which is much more than half as long between the mid and hind coxae as the metepisternum. However, on *Neosibariops* the metasternum is but half as long as the metepisternum. Because of our inadequate knowledge of the Pacific Baridinae, I believe it best to place *Neosibariops* tentatively as a close ally of *Limnobaris,* subject to change or suppression when new and more complete data are compiled. It most certainly is not a *Baris* or a close ally of *Baris,* and to leave the species in that genus would only add to the confusion of the Fijian Baridinae. The genotype of *Limnobaris,* the European *L. T-album,* is narrower, more elongate, more parallel-sided and more densely squamose, and the rostrum is stouter and only about three fourths as long (measured along the ventral margin) as the prothorax

in both sexes; whereas *Neosibariops nemorhina* is shorter, more laterally convex, has the metasternum somewhat shorter in comparison to the metepisternum, and the rostrum is much more slender and fully as long as the prothorax in the male. Beside these differences, the pygidium on *Limnobaris T-album* is horizontal and entirely concealed. These differences are, I believe, sufficient in themselves to warrant the separation of *Neosibariops* from *Limnobaris*. Probably when more material is studied and both sexes are examined, additional characters will be found to distinguish *Neosibariops* from other genera.

3. **Neosibariops nemorhina** (Lea), new combination.

Baris nemorhina Lea: Linn. Soc. N. S. Wales, Proc., **56**: 153, fig. 24, 1931.

Derm black, shiny, elytra somewhat diluted with red, appendages reddish; setae white.

Head finally and densely reticulate, very minutely punctate, the punctures separated by distances greater than their diameters and bearing minute, hardly discernible setae; with a distinctly transverse groove connecting the posterior margins of the eyes and separating the interocular area from the crown, the punctures in the interocular area coarse, similar to and continuous with those on the rostrum, their setae larger and more conspicuous. *Rostrum* rather evenly curved, as long along the ventral edge as from the base of the prothorax to the cephalic groove between the eyes; very slender, slightly angular and with a rather distinct median line from base to the antennae above; punctures finer beyond the antennae. *Prothorax* distinctly broader than long (3:2.25), almost subparallel-sided, but slightly arcuate on the sides from the base to the apical third and thence distinctly constricted, the apex slightly subtubulate; the disk evenly set with medium-sized punctures separated by interstices equal to or slightly greater than their diameters, but with the median line impunctate, the punctures larger and coarser on the sides; the setae borne by the punctures prostrate, more conspicuous on the sides than on the disk. *Elytra* about three fourths as broad as long, more than twice as long as the prothorax (4.5:2), slightly arcuate on the sides from the base to the declivity and thence more rapidly rounded to the apex; striae coarse and deep, the punctures slightly broader than the striae at the base; intervals flat, each with a row of small punctures bearing narrow, prostrate blunt-tipped setae. *Legs* with the femora with small punctures bearing prostrate setae somewhat longer than those on the elytra; tibiae with the setae becoming longer, finer and denser toward the apex. *Sternum* with the prosternum densely, coarsely, in places subconfluently punctate, the subapical constriction continued prominently across it; metasternum densely punctate, the punctures coarser on the sides and there bearing more prominent setae, flattened in the middle, hind margin distinctly emarginate in the middle, one half as long between the mid and hind coxae as the metepisternum which is clothed with narrowly triangular squamae that do not overlap one another. *Venter* with the first two ventrites flattened down the middle, the

punctures there shallower and less dense than on the sides; three and four with only a single row of punctures along the middle but densely punctate on the sides; five densely punctate except along the base at the middle. *Pygidium* densely and confluently punctate, rounded behind. Length, 2.8 mm.; breadth, 1.4 mm.

Holotype male labeled "Fiji" with no additional data, but in the original description Lea has noted "(Dr. W. Horn, from—Kraatz). Unique."

Lea wrote that the femora were grooved, but they are not at all grooved.

Genus HETEROBARIS, new genus

Head continuous in outline with the rostrum, without a transverse groove or impression above the eyes; interocular area somewhat narrower than the base of the rostrum. *Rostrum* evenly arcuate, rather thick, distinctly shorter along the lower edge than the pronotum, expanded beyond the antennae which are inserted slightly behind the middle (measured along the lower edge); mandibles bidentate and decussate. *Antennae* with the scape as long as the first five funicular segments, not quite reaching the eye; first funicular segment as long as two plus three, the following segments successively shorter, the seventh transverse; club elongate-oval, as long as the four preceding segments, 4-segmented, the first segment making up fully one half its mass, setose throughout. *Prothorax* as long as broad, base bisinuate, arcuate on the sides, apical margin truncate dorsally and laterally. *Legs* with all the femora grooved for the reception of the tibiae, not toothed; tibiae not carinate, hardly expanded distally, the uncus arising from about the middle of the apex and without a tooth on the inner apical angle; tarsi with the first segment as long as two plus half of three, two longer than broad, about as long as three, four projecting beyond three for about the length of three, the claws free and divergent. *Sternum* with the prosternum deeply caniculate, the side walls high, projecting backward in distinct points over the fore coxae which are flattened internally; the median prosternal post-coxal piece slightly produced backward and on a line with the anterior margins of the mesocoxae; fore coxae separated at the base for less than half the diameter of a coxa, the flattened inner sides of the coxae sloping outward; mesocoxae separated by the breadth of a coxa; metasternum between the mid and hind coxae three fifths as long as the metepisternum. *Venter* with the first two ventrites fused, the fifth as long as three plus four. *Pygidium* rather broadly exposed from above in both sexes.

Genotype: *Solenobaris spathulirostris* Lea.

This genus greatly resembles *Nesobaris* but cannot be placed with that genus because of its exposed pygidium.

I cannot understand why Lea placed *H. spathulirostris* in his genus *Solenobaris*. In the genotype of *Solcnobaris, S. decipiens* Lea, the rostrum is discontinuous in outline with the head, the femora have teeth on the inner and outer margins of the ventral sulcus, the pro-

sternal canal terminates in a distinct open receptacle formed by a prominent transverse wall across the median post-coxal piece of the prosternum which greatly resembles the mesosternal receptacle of the Cryptorhynchinae, and the body is sub-rhomboidal, giving a distinct facies to that genus.

4. **Heterobaris spathulirostris** (Lea), new combination.
Solenbaris spathulirostris Lea: Linn. Soc. N. S. Wales, Proc., **56**: 159, 1931.

Derm black, shiny, the appendages somewhat diluted with red.

Head reticulate, with small punctures on the crown separated by distances about equal to their diameters, setae inconspicuous; interocular area not more coarsely punctured, distinctly and finely setose along the inner margins of the eyes. *Rostrum* sexually dimorphic, slightly expanded beyond the antennae in the male, the apex not much broader than the base; rapidly and conspicuously expanded beyond the antennae in the female, the apex much broader than the base, somewhat laterally compressed behind the antennae, with a vague dorsal median line. *Prothorax* shallowly bisinuate at the base, slightly arcuate on the sides from the base to just before the apex and there with a distinct, narrow, subapical constriction appearing as an impressed line; finely and minutely reticulate; very finely punctate, the punctures shallow and separated by distances somewhat greater than their diameters; the setae hardly discernible. *Elytra* twice as long as the pronotum, base subtruncate, not sinuate, almost straight and subparallel-sided, but slightly narrowing, from the humeri to near the declivity and thence rounded to the apex which is conjointly emarginate; striae very narrow but conspicuous, the punctures larger at the base and there fully twice as broad as the striae; intervals flat, with minute punctures bearing fine, rather inconspicuous setae; without any dorsal impressions or irregularities. *Legs* with the femora with small punctures bearing brassy setae, the fore pair with the inner margin of the ventral sulcus finely serrate. *Sternum* with the prosternal furrow marked behind the fore coxae by slight elevations, at least in the female; metasternum evenly set with comparatively large, round punctures, separated by distances not as great as their diameters; each puncture bearing a slender, recurved, conspicuous seta, the setae in the middle distinctly longer than the diameter of the punctures. *Venter* with the punctures on the first two segments less dense and considerably smaller than those on the metasternum; ventrites three and four with setigerous punctures from side to side; ventrite five with the punctures denser and somewhat coarser than those on the first two ventrites and with the setae more conspicuous. *Pygidium* conspicuous, densely set with rather coarse setigerous punctures. Length, 2 mm.; breadth, 0.8 mm.

Holotype male, and one female collected by Lea on Viti Levu.

Lea described the rostrum as being as long as the prothorax, but I have found it to be shorter in both sexes, and the antennae are inserted slightly behind the middle instead of beyond the middle.

Genus NESOBARIS Marshall, 1931

Head continuous in dorsal outline with the rostrum; the interocular area narrower than the base of the rostrum. *Rostrum* shorter along the ventral margin than the head and pronotum; antennae inserted at about the middle, measured along the ventral margin; mandibles bidentate and decussate. *Antennae* with the scape not quite reaching the eye, somewhat shorter than the funicle excluding the club; first funicular segment as long as two plus three, seventh broadest and closely annexed to the club which is pubescent throughout. *Prothorax* broader than long; base bisinuate. *Legs* with the trochanters bearing an erect seta; femora shallowly impressed or deeply grooved below for the reception of the tibiae, not toothed; tibiae not widened distally, with a small tooth at the inner apical angle, at least on the fore pair, or with a distinct angulation, the uncus on the outer apical angle well developed; tarsi with the claws very small. *Sternum* with the prosternum deeply caniculate; mesocoxae separated by much more than the breadth of a coxa; metasternum between the mid and hind coxae about half as long as the metepisternum. *Venter* with the first two ventrites fused; fifth ventrite about as long as three plus four. *Pygidium* but narrowly exposed or completely concealed from above, distinctly but narrowly visible below.

Genotype: *Nesobaris tutuilae* Marshall.

I have expanded Marshall's generic description of *Nesobaris* [Insects of Samoa, 4(5): 313, 1931] to include two of Lea's "Baris." I have had before me the following specimens: the unique male holotype of the genotype, *Nesobaris tutuilae* Marshall, the unique female holotype of *Baris vitiensis* Lea, and the unique female holotype of *Baris basipennis* Lea. Placing Lea's two species in this genus results in a heterogeneous group of four species under one generic name that does not satisfy me. I believe that the Fijian species must eventually be removed from *Nesobaris,* but I think it best that they be tentatively referred to *Nesobaris* until larger series are available for study. There are characters displayed on both *"Baris" vitiensis* and *"Baris" basipennis* that do not conform to the corresponding structural features of the genotype of *Nesobaris.* Unfortunately both of Lea's types are partially dissected, the elytra are loosened from their natural positions, and both specimens appear to have died with their abdomens drawn downward away from the elytra and broadly exposing the pygidium from above as well as the sides of the last two or three tergites. The ridge or line which fits against the elytra is discernible, however, and shows that the abdomen is in an abnormal position. It is quite possible that my assumption that the pygidium is normally narrowly exposed from above is erroneous and that in life it is plainly visible from above. Only study of additional specimens of both sexes will

solve this problem. If the pygidium is exposed from above, then the two Lean species must be removed from *Nesobaris* and perhaps placed near or in *Heterobaris*. The femora on both the Fijian species are deeply grooved for the reception of the tibiae, whereas on the genotype and its Samoan congener the femora are but feebly impressed. I am almost convinced that the four species that now constitute *Nesobaris* belong to two or three genera, but am unwilling to divide them upon characters displayed by the unique and imperfect specimens at hand.

It is quite evident that Lea did not understand the structural characteristics of the genus *Baris* when he described the two Fijian species. No species with the structure of the head, rostrum, antennae, legs, and sterna such as displayed by these two species can possibly be placed in *Baris*.

Key to the Fijian Nesobaris

Prothorax coarsely and subreticulately punctured, the punctures very close, their interstices distinctly narrower than their diameters on the sides of the disk; elytra strongly gibbous at the base, the dorsal outline uneven, the discal striae distinctly more coarsely sculptured at the base; scales or squamiform setae yellow; pectoral canal deep between the fore coxae and continued from the base to the apex of the prosternum on about the same plane.......................**N. basipennis** (Lea).

Prothorax very finely punctured, the punctures small and shallow, separated by interstices as broad or broader than their diameters; elytra with the dorsal contour not irregular, not gibbous at the base; scales white; pectoral canal comparatively shallow between the fore coxae, and not continued behind them....... ....**N. vitiensis** (Lea).

5. **Nesobaris basipennis** (Lea), new combination.

Baris basipennis Lea: Linn. Soc. N. S. Wales, Proc., **56**: 153, 1931.

Female. Derm reddish brown to black; the larger dorsal setae and squamae yellow.

Head coarsely reticulate, shallowly punctate, more coarsely punctate between the eyes, the punctures there bearing longer setae. *Rostrum,* including the mandibles, slightly shorter along the lower margin than the pronotum, gradually and slightly expanded from base to apex, coarsely punctate at the base only, thence shiny and minutely punctate to the apex, sulcate and more coarsely sculptured on the sides from the base to the antennae, which are inserted slightly beyond the middle. *Antennae* with the scape as long as the first six funicular segments; second funicular segment longer than the third, three to seven evenly and successively broader; club about as long as the preceding four funicular segments, its basal segment not making up half its mass.

Prothorax conspicuously transverse, rounded on the sides from the strongly bisinuate base almost to the apex and there with a narrow, sharply defined subapical constriction; the apical margin not truncate on the sides but slightly sinuous, the dorsal apical margin slightly produced over the head; very coarsely punctate throughout, especially on the sides, somewhat less coarsely on the disk, the interstices on the sides of the disk not as broad as the diameters of the punctures; with a few, erect, yellow setae on the disk and with numerous, less conspicuous, black setae at the apex. *Elytra* not much longer than broad, twice as long as the prothorax; distinctly gibbous at the base; basal margin deeply emarginate at the scutellum and thence almost straight to the humeri; striae narrow but deep, the punctures obsolescent in the middle of the disk, but coarse and broader than the striae at the base, striae seven and eight terminating on the apex of the humerus and not reaching the base; intervals much broader than the striae, coarsely sculptured on the gibbous basal area, otherwise each with a single row of minute punctures bearing very small bronzed setae; with scattered, elongate, yellow, squamiform setae. *Legs* with the femora coarsely reticulate, with small punctures bearing fine setae; fore tibiae with a well-developed tooth at the inner apical angle, the tooth smaller on the mid and hind pair; tarsi with the first segment longer than the second which is as broad as long, fourth segment projecting about half its length beyond the deeply bilobed third segment, the claws very small, pale, connate at the base. *Sternum* with the prosternum deeply and broadly caniculate from base to apex, the side wall produced over the coxa in a sharp point, the intercoxal piece about as broad as a coxa; metasternum coarsely punctate, the punctures larger and denser on the sides, reticulately placed between the mid and hind coxae. *Venter* with the first two ventrites sparsely and minutely punctate, ventrites three and four with a row of small punctures across the middle, ventrite five with about three rows of punctures. *Pygidium* narrowly exposed from above and below. Length, 1.8 mm.; breadth, 1.0 mm.

Holotype female collected by Lea on Viti Levu.

This is a distinct component of the Fijian barid fauna owing to its gibbous elytra and scattered yellow squamiform setae. Its pectoral canal is quite different than that of *N. vitiensis* and the tarsal claws are connate at the base. This latter character is not found on the other species of the genus. It is an aberrant form which may require a new genus for its reception.

6. **Nesobaris vitiensis** (Lea), new combination.

Baris vitiensis Lea: Linn. Soc. N. S. Wales, Proc., **56**: 153, 1931.

Derm black, comparatively shiny, appendages slightly diluted with red; squamae white.

Head finely reticulate, sparsely and minutely punctate on the crown, the punctures denser between the eyes, each puncture bearing a short, fine, prostrate setae. *Rostrum* subcylindrical, rather slender, gradually and slightly widened from base to apex, evenly arcuate, the ventral margin as long as the head and pronotum; antennae inserted at slightly beyond the middle, measured along the

lower edge. *Antennae* with the scape fully as long as the funicle excluding the club; second funicular segment somewhat longer than three, the following segments successively slightly broader; club as long as the preceding five funicular segments, 4-segmented, the basal segment making up more than half its mass, densely setose throughout. *Prothorax* one fourth broader than long, rather evenly rounded on the sides from the strongly bisinuate base almost to the apex and there with a rather shallow but distinct subapical constriction; apical margin slightly arcuate above, not quite truncate on the sides; discal punctures very small, separated by interstices equal to or greater than their diameters, the punctures becoming larger, coarser and denser on the sides, each puncture bearing a short, fine, prostrate, inconspicuous seta. *Elytra* almost five sixths as broad as long, more than twice as long as the prothorax; base broadly and deeply emarginate at the scutellum and thence slightly sinuous to the humeri, slightly narrowed on the sides from the base to the declivity and thence broadly rounded to the apex; striae narrow and deep, seventh and eighth terminating on the humerus and not reaching the base, their punctures conspicuous at the base of the first two or three striae only, and there broader than the striae, elsewhere smaller, slightly broader than the striae at the base, but obsolete behind; intervals flat on the disk, the first three somewhat more coarsely sculptured at the base, flat on the disk, each bearing a row of minute punctures bearing very small, fine, prostrate setae; interval three bearing a cluster of about five prostrate, lanceolate, pure white squamae at slightly behind the middle and two at its apex; interval seven with two similar squamae near its apex just above its junction with the ninth. *Legs* with the femora deeply sulcate below, with small punctures bearing slender, white, prostrate setae, those on the upper side broader and squamiform near the apex; tibiae not broadened distally, the outer apical angle bearing a strongly developed, arcuate uncus, the inner apical angle at most acutely angulate but not bearing a distinct tooth; tarsi with the first segment about as long as two plus three, two hardly longer than broad, three rather short, four projecting beyond three for fully the length of the third segment, the claws very small, pale, free, and divergent. *Sternum* with the prosternum deeply caniculate before the front coxae, rather shallowly caniculate between them, and convex and not caniculate behind them, the side margins of the canal sharp but not projecting backward as pointed protuberances over the coxae, the intercoxal piece slightly narrower than a coxa, the basal median piece not produced backward, rather densely clothed with long, white, squamiform setae; metasternum with large, shallow punctures bearing fine setae in the middle, the punctures becoming coarser and denser laterally, the setae broader between the mid and hind coxae. *Venter* with the first two ventrites with small punctures bearing conspicuous setae, more abundant toward the sides; ventrite five densely punctate at the sides and apical half, the setae longer than the diameters of the punctures and conspicuous. *Pygidium* narrowly visible from above and below. Length, 1.9 mm.; breadth, 1.0 mm.

Holotype female collected by Lea on Viti Levu.

The longer, slender rostrum, incomplete prosternal canal, and the small patches of white squamae on the elytra will readily distinguish this species from all the other members of the genus.

Genus NEOEREMONYX, new genus

Head continuous in dorsal outline with the rostrum; interocular area narrower than the base of the rostrum. *Rostrum* short and thick, slightly arcuate, only about three fourths as long, along the lower edge, as the pronotum; the antennae inserted at or slightly behind the middle; mandibles bidentate and decussate. *Antennae* with the scape not longer than the first four funicular segments; first funicular segment as long as two plus three, the seventh closely annexed to the club, its outline subcontinuous with the club; club 4-segmented, the first segment bare and shiny and making up fully half its bulk. *Prothorax* broader than long, base shallowly bisinuate, dorsal apical margin rounded, projecting somewhat over the base of the head, lateral apical margin oblique. *Legs* with the trochanters bearing an erect seta; the femora deeply grooved for the reception of the tibiae, edentate; tibiae not expanded distally, the inner apical angle with a small tooth or angulation, the outer apical angle with a strongly developed uncus; tarsi with the first segment longer than the second, the second hardly as long as broad, fourth projecting beyond the third for almost the length of the third and bearing but a single minute claw. *Sternum* with the prosternum deeply caniculate, the side walls of the canal high and prominent, the intercoxal piece not produced backward; mesocoxae separated by a distance much greater than the diameter of a coxa; metasternum between the mid and hind coxae about half the length of the metepisternum. *Venter* with the first two ventrites fused; fifth ventrite somewhat longer than three plus four. *Pygidium* entirely concealed from above in both sexes, narrowly exposed from below in the male.

Genotype: *Solenobaris nitidiventris* Lea.

This genus is closely allied to *Eremonyx* Marshall, 1931. *Neoeremonyx* differs from *Eremonyx* principally as follows: in *Neoeremonyx* the head and rostrum form a continuous curve, but in *Eremonyx* the head and rostrum are separated by a transverse impression; in *Neoeremonyx* the interocular area is distinctly narrower than the base of the rostrum, in *Eremonyx* the frons is as broad as the rostrum in its basal half; the anterior margin of the prothorax in *Neoeremonyx* is not truncate dorsally and laterally and it projects over the base of the head and does not leave the head so broadly exposed as in *Eremonyx*; the femora of *Neoeremonyx* are all deeply grooved and edentate, whereas on *Eremonyx* they are shallowly grooved and the front femora are toothed.

Why Lea placed *N. nitidiventris* in *Solenobaris* is beyond my comprehension. The two genera belong in widely separated sections of the subfamily. *Solenobaris* has a characteristic prosternal receptacle, the head and rostrum are discontinuous, the femora are conspicuously toothed, the tarsal claws are in pairs, and the pygidium is distinctly and broadly exposed from above.

7. **Neoeremonyx nitidiventris** (Lea), new combination.
Solenobaris nitidiventris Lea: Linn. Soc. N. S. Wales, Proc., **56**: 159, 1931.

Derm black, shiny, the appendages not conspicuously paler than the body. *Head* coarsely, subconfluently or confluently punctured throughout, the interstices forming strigulae on the crown; without any conspicuous setae. *Rostrum* coarsely punctate in the male, the punctures somewhat longitudinally confluent; more shiny, much less coarsely punctate, the punctures more distinctly separated in the female. *Antennae* inserted at about the middle of the rostrum in the male and slightly behind the middle in the female. *Prothorax* shallowly bisinuate at the base, roundly narrowing on the sides from the base almost to the apical margin and there very slightly constricted; finely alutaceous, densely and evenly punctate, the punctures on the disk small and separated by interstices as broad as their diameters, the punctures denser and coarser on the sides; without setae. *Elytra* somewhat less than three fourths as broad as long, two and two thirds as long as the prothorax; base deeply and rather narrowly emarginate at the scutellum, but slightly concave, almost truncate on either side; slightly subcuneiform in shape, the sides arcuately narrowing from the feebly developed humeri to the apex which is slightly, conjointly emarginate; striae narrow, but deep and conspicuous, the punctures coarse and conspicuous at the base and there much broader than the striae, but becoming smaller posteriorly and hardly discernible past the middle on the disk; intervals flat on the disk, slightly convex behind, their punctures minute and bearing only microscopic, specklike, hardly discernible setae that can be seen only in certain lights. *Legs* with the femora rather coarsely punctate, the setae inconspicuous. *Sternum* with the side walls of the pectoral canal projecting backward under the fore coxae in distinct, pointed processes, the side wall marked by a small, raised process behind the fore coxae; mesosternum between the fore and mid coxae coarsely and densely punctate; metasternum densely punctate, the punctures coarser and denser on the sides, the posterior margin broadly emarginate. *Venter* with the first two ventrites concave in the female, flattened in the male, their punctures much smaller, sparser and shallower than those of the metasternum, without conspicuous setae; ventrite five densely and rather coarsely punctate toward the apex, with a conspicuous median impression and with the hind margin distinctly sinuous in the male, without a distinct median impression and with the hind margin strongly convex and not at all sinuous in the female. *Pygidium* narrowly exposed below in the male, concealed in the female. Length, 2.2-2.4 mm.; breadth, 1-1.2 mm.

Holotype male and one male paratype collected by Lea on Viti Levu, and allotype female collected by E. H. Bryan, Jr., at Colo-i-suva, Viti Levu, June 28, 1924. Because the female was not previously described, I have designated the one before me as the allotype; it will be stored in Bernice P. Bishop Museum.

OCCASIONAL PAPERS

OF

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

Volume XIV | April 15, 1939 | Number 21

Santalum ellipticum, a Restatement of Gaudichaud's Species

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Santalum ellipticum Gaudichaud, the *iliahi aloe* or lowland sandalwood of the Hawaiian islands, is redefined as a single species, exhibiting phenotypic epharmosis and normal variation in flower length, which occurs on Laysan, Oahu, Molokai, Lanai, Maui, Kahoolawe, and Hawaii. *S. ellipticum* var. *littorale, S. cuneatum, S. cuneatum* f. *gracilius,* and *S. cuneatum* var. *laysanicum* are reduced to synonyms of *S. ellipticum.*

During botanical investigations in the arid lowlands of Oahu, carried on for nine months, considerable difficulty was encountered in separating the species, forms, and varieties of the *iliahi aloe* or lowland sandalwood of the Hawaiian islands. Such separation as could be effected was forced and unnatural in the light of actual occurrence, and did not take into account the influence of local site factors on the form and appearance of the plant.

Hawaiian species of the genus *Santalum* have been studied and revised by Skottsberg (Bishop Mus., Bull. 43, 1927). In this excellent revision two species-groups are established: (1) the *freycinetianum*-group with four species, one each on Kauai, Oahu, Maui, and Lanai; and (2) the *ellipticum*-group with four species, of which *Santalum ellipticum* Gaudichaud is restricted to Oahu, two are restricted to Hawaii, and *Santalum cuneatum* (Hillebrand) Rock occurs on Oahu, Molokai, Lanai, Maui, Kahoolawe, Hawaii, and Laysan. Skottsberg recognizes the close relationship between *Santalum ellipti-*

cum and *S. cuneatum,* and the difficulty of separating them by leaf form. His segregation is based entirely on the length of flower and style, though he states that he has not seen the flowers of Gaudichaud's type specimen. He describes *S. ellipticum* as having flowers 4-5 mm. long; *S. cuneatum,* as having flowers 5-7 mm. long.

The revision of *Santalum ellipticum* Gaudichaud presented in this paper is based on the acceptance of the following taxonomic concepts. 1, Geographical isolation in the islands by itself is not considered sufficient cause for the establishment of a segregate. 2, If a segregate has been described as having certain characters and differences, and these characteristics are proved to be invalid or nonexistent, and no additional characteristics can be determined, the segregate is reduced to synonomy. 3, When morphological variations occur within a restricted geographical range and appear to be correlated with the local existing site factors, and when the variations are related to each other by all degrees of intergradations and distribute themselves so as to form a normal distribution curve, the actual naming of such variations is considered scientifically superfluous. 4, When forms are striking and aberrant, when they apparently are not induced by existing ecological factors, and when they are not related by gradations with the general type, they are considered worthy of taxonomic recognition.

The present investigation within the *ellipticum*-group of Hawaiian *Santalum* is concerned in the first place with the validity of *S. cuneatum* as a distinct species, and in the second place with the status of the varieties and forms of both *S. ellipticum* and *S. cuneatum* as maintained by Skottsberg.

The validity of *S. cuneatum* as a species distinct from *S. ellipticum* is dependent on a consistent difference in the length of the flowers. Field investigation revealed that variation in flower length in each of two colonies of lowland sandalwood was such as to overlap the ranges of both species. Considering the relative rarity of the plant, it must be assumed that each colony was nevertheless a single interbreeding group, within which this character was variable. Furthermore, a study of herbarium material showed that minimum and maximum flower lengths from any one collection exhibit a remarkably small variation, exceeding one millimeter in only ten percent of the specimens. When these data are graphed, the resulting curve is the normal bell-shaped type, with a single peak near the mean of five millimeters,

a condition indicating normal variation of the character concerned. Such evidence eliminates any second species of *Santalum* based on flower length. Further study of herbarium material revealed no characteristics which could be used to segregate an additional species.

Table 1. Minimum and maximum lengths of flowers of Santalum ellipticum Gaudichaud[1]

Collection	Length of flowers in mm. Minimum	Maximum
Hawaiian islands:		
Forbes	5.0	6.0
Hillebrand and Lydgate, ex Lydgate	4.0	5.0
U. S. Exploring Expedition*	6.0	6.0
Laysan:		
Bryan	4.5	5.5
Bryan 1903*	5.0	5.0
Bryan 1903 (S. cuneatum var. laysanicum)	5.0	5.0
Fullaway 1912 (S. cuneatum var. laysanicum)	5.5	6.5
Schauinsland 1896-97, type	4.5	5.5
Snyder May 1902*	4.0	6.0
Oahu:		
Bryan 1903	5.0	6.0
Christophersen, Wilder, and Hume 1504	5.0	6.5
Christophersen, Wilder, and Hume 1710	6.0	7.0
Christophersen, Wilder, and Hume 1439	4.5	6.0
Degener 3701*	4.0	4.0
Degener 5301*	4.0	5.0
Degener 5313B*	5.0	6.0
Degener 5321*	5.0	6.0
Degener 5324*	3.0	4.0
Degener 5327*	3.0	3.0
Degener 5328*	5.5	6.5
Degener 5330*	4.0	4.0
Degener 5331*	4.0	5.0
Degener 11323*	3.0	4.0
Degener 11324*	5.0	5.0
Egler 37-101	4.5	6.0
Egler 37-115	4.0	5.0
Egler 37-116	5.0	7.0
Egler 37-418	4.0	5.0
Egler 37-420	4.0	5.0
Forbes 1078 (S. cuneatum)	6.0	7.0

[1] Data were obtained from not less than six measurements from each herbarium sheet. The Latin names in parentheses are those of the collections cited and named by Skottsberg (Bishop Mus., Bull. 43, 1927, and elsewhere). Collections marked with an asterisk are on file in the herbarium of the New York Botanical Garden; all others are in the herbarium of Bishop Museum.

Collection	Length of flowers in mm. Minimum	Maximum
Forbes 1078*	6.0	6.5
Forbes 1445 (S. ellipticum)	3.5	4.5
Forbes 1653 (S. ellipticum)	4.0	5.5
Forbes 1755 (S. cuneatum)	5.0	6.0
Forbes 2276 (S. ellipticum var. littorale)	4.0	5.0
Forbes 2343 (S. cuneatum)	4.0	5.0
Forbes 2442 (S. cuneatum f. gracilius)	5.5	6.0
Forbes 2442*	5.0	5.5
Hillebrand, Kaneohe	4.5	5.0
Hume 160	3.0	4.0
Judd 36 (S. cuneatum) ?	6.0	7.0
Judd 57	5.0	6.0
Judd 59 (S. ellipticum)	3.0	4.0
Judd and Hosaka 2/28/32	4.0	4.5
Neal 7/12/34	5.0	6.0
Rock 12513 (S. cuneatum)	3.0	4.0
Rock 12514	5.0	6.0
Rock 17028	4.0	5.0
Shaw 5920	3.5	5.0
Shaw 8119	4.0	5.5
Shaw 8301	5.0	5.5
Shaw 8348	4.5	5.5
Shaw 8864	4.5	5.5
Shaw 8864	4.5	5.5
Shaw 10091	4.0	5.0
Shaw ex Rock 12514 (S. cuneatum)	5.5	6.0
Skottsberg 118 (S. cuneatum f. gracilius)	6.0	7.0
Stokes 5/2/20	5.0	7.0
Molokai:		
Brigham	5.5	6.0
Degener 5310*	4.0	5.0
Forbes 178	3.5	4.5
Forbes 178 (S. cuneatum)	4.0	5.0
Forbes 353	5.0	6.0
St. John et al. 12693	4.0	5.0
Lanai:		
Forbes 163	6.0	7.0
Forbes 293 (S. cuneatum)	3.5	4.5
Forbes 293	4.0	5.0
Forbes 293*	4.0	4.5
Hillebrand, ex. Mus. Bot. Berol.	3.5	4.5
Mann and Brigham 353 (S. cuneatum)	4.0	5.0
Munro 23 (S. cuneatum)	4.5	5.5
Munro 33	5.0	6.0
Munro 82	5.0	6.0
Munro 98	5.5	6.5

Collection	Length of flowers in mm. Minimum	Maximum
Munro 119	6.0	7.0
Munro 11/6/13	5.0	6.0
Munro 10/19	5.0	6.0
Munro 10/19*	6.0	6.0
Rock 8004 (S. cuneatum)	4.0	5.0
Rock 8004*	3.0	4.0
Rock 8013 (S. cuneatum)	5.0	7.0
Rock 8013*	6.0	7.0
Rock 8048 (S. cuneatum)	4.0	5.0
Maui:		
Degener 5303*	4.0	5.0
Forbes 84 (S. cuneatum)	6.0	7.0
Forbes 1928	5.0	6.0
Forbes 2478	5.0	5.0
Rock 8683 (S. cuneatum)	5.0	6.0
Rock 8683*	5.0	6.0
Hawaii:		
Neal 345	4.0	5.0

The status of the described varieties and forms of *Santalum ellipticum* and *S. cuneatum* cannot rest on an evaluation of morphological differences alone. In general, it may be said that botanists have not always appreciated the effects of the extraordinary extremes in soil moisture, insolation, wind action, and other ecological factors that often exist in close proximity in tropical arid lowlands. These factors are correlated with the protection offered by the topography, with the depth of the soil, and with the development of a closed mature vegetation. These conditions are correlated with striking differences in the form and manner of growth of both indigenous and established alien plants. In some Hawaiian species, variations in the size, shape, and succulence of the leaf, and in the height of the plant correspond closely with local site factors, and are such that when interpreted from herbarium material, in the light of the taxonomy of the plants of temperate regions, they may be given a more important taxonomic significance than they deserve.

Santalum ellipticum var. *littorale* was investigated at the ruins of the Hawaiian village near the sea at Waimanalo where there is a colony of over 100 individuals. Flower sizes on individual plants fit the concepts of both *S. cuneatum* and *S. ellipticum*. No characteristics of flower or fruit were discovered which might differentiate these

plants in any way from other collections of sandalwood from the dry lowlands of Oahu. In habit and growth form the plants are low, wind-clipped, and bear relatively thick leaves, thus conforming to the adjacent, severely clipped plants of the introduced hau, *kiawe, klu,* lantana, and *koa haole.* The characteristics of this sandalwood segregate are apparently induced by the peculiar local environmental conditions. There is nothing to indicate that their genetic constitutions are distinct.

Santalum cuneatum f. *gracilius* was established by Skottsberg in 1926, being based on Skottsberg 118, Ewa coral plain, Oahu. It is characterized as a small tree with slender pendulous branches, with relatively thin leaves and long petioles; the flowers are 6.0-7.0 mm. long. I investigated this form in the type locality, and found that it cannot be interpreted properly without reference to the habitat. The Ewa plain is a raised reef lying 3-15 meters above sea level and covered by a dry open forest of *kiawe.* The soil is thin or absent and conditions are very unfavorable for plant growth. The topography is characterized locally by pits in the fossil reef, often as much as 10 feet in diameter and 15 feet deep. In these depressions, the favorable edaphic and atmospheric conditions permit the growth and development of species of the moist montane flora. Furthermore, there is a striking difference between the habit and form of dry-land plants growing in these moist depressions and those growing on the dry reef surface and on the near-by strand. This is true both for introduced herbs and shrubs and for native plants, including *Capparis sandwichiana* DC. and *S. cuneatum* f. *gracilius.* Variations in height and in foliage of individual specimens of *Santalum* are beyond the limitations of *S. cuneatum* f. *gracilius,* and intergrade with those of *S. cuneatum.* The differences are directly correlated with the favorableness of the site on which the plant grows. Until other differences are discovered, independent of local habitat factors, this *Santalum* must be considered as typical *S. ellipticum.*

Santalum cuneatum var. *laysanicum* Rock was based on Schauinsland 1896-97, Laysan Island. A study of the type collection and other collections in Bishop Museum revealed no characteristics which could be satisfactorily used to separate the Laysan plants from those of the *ellipticum*-group of other Hawaiian islands. Flower length varies normally. Leaf shape varies from suborbicular to elliptical, paralleling the variations on other islands. Leaves are generally but not always

succulent, and are similar to those on plants growing near the sea on Oahu. A photograph of the type locality on Laysan, taken by E. L. Caum, amply shows the very severe conditions and exposure under which these plants grow. The form of the shrub and the succulence of leaf are obviously related to these local site conditions. Geographical isolation is its only claim to taxonomic status.

In accordance with the evidence given in the preceding paragraphs, *Santalum ellipticum* Gaudichaud may now be restated and its synonomy and history revised.

Santalum ellipticum Gaudichaud

Santalum ellipticum Gaudichaud, in Freycinet, L., Voyage autour du monde, Bot., 442, 1826-30 (non vide).

Santalum freycinetianum var. *latifolium* A. Gray, Diagnoses of the species of sandalwood (Santalum) of the Sandwich Islands: Am. Acad. Proc., **4**: 327, 1860 (Maui specimens, not Hawaii specimens).

Santalum "freyienetianum" var. *ellipticum* Mann, Enumeration of Hawaiian plants: Am. Acad. Proc., **7**; 198, 1867 (spelled correctly *freycinetianum* in the index).

Santalum freycinetianum γ var. *cuneatum* Hillebrand, Flora of the Hawaiian islands, 389. Heidelberg, 1888.

Santalum freycinetianum ϵ var. *littorale* Hillebrand, op. cit., 390.

Santalum cuneatum Rock, The sandalwoods of Hawaii: Bd. Agric. and Forestry, Terr. Hawaii, Bot. Bull., **3**: 37, pl. 11, 1916.

Santalum cuncatum var. *laysanicum* Rock, op. cit., 39, pl. 12.

Santalum littorale Rock, op. cit., 41, pl. 13.

Santalum cuneatum f. *gracilius* Skottsberg, Acta Horti Gothoburgensis, **2**: 222, 1926 (published with description in Bishop Mus., Bull. **43**: 59, 1927).

Santalum ellipticum var. *littorale* Skottsberg, Artemisia, Scaevola, Santalum, and Vaccinium of Hawaii: Bishop Mus., Bull. **43**: 55, 1927.

Santalum ellipticum Gaudichaud, as presented above, has been variously treated by Hawaiian botanists. This species, originally described from Oahu material by Gaudichaud, was further described by A. de Candolle (Santalaceae, Prod., **14**: 682, Paris, 1857). Concerning this species, Gray wrote: "Foliis chartaceis ellipticis oblongis seu ovali-obovatis, petioli gracili; cymis paniculisve saepius axillaribus; perigonii tubo brevi, lobis ovatis; fructu *S. freycinetiani.*" It is ap-

parent that Gray was referring to Gaudichaud's species. Gray's *Santalum freycinetianum* var. *latifolium* is based on Maui specimens of *S. ellipticum* and on Hawaii specimens of *S. paniculatum* Hooker and Arnott. Mann (1867) reduced Gaudichaud's *S. ellipticum* of Oahu to a variety of *S. "freyienetianum"* and accepted Gray's *S. freycinetianum* var. *latifolium,* adding Lanai specimens of *S. ellipticum.* Wawra (Flora, **58**: 172, 1875), while preserving *S. freycinetianum* var. *latifolium* for Maui specimens of *S. ellipticum,* did not separate any other sandalwoods of the *ellipticum*-group from *S. freycinetianum.* Sinclair (Indigenous flowers of the Hawaiian islands, 34, pl. 34, 1885) misused the name *S. ellipticum* for *S. pyrularium* A. Gray. Hillebrand (1888) distributed *S. ellipticum* among four varieties of the unrelated *S. freycinetianum*: (1) var. *latifolium,* including *S. paniculatum* from Hawaii, and the Maui, Kahoolawe, and Molokai specimens; (2) var. *cuneatum,* for Lanai specimens; (3) var. *ellipticum,* including an unrelated Kauai *Santalum* and the Oahu specimens; and (4) var. *littorale,* for the Oahu plants growing near the sea. The sandalwood called *S. ellipticum* by Heller (Minn. Bot. Stud., **1**: 818, 1897) was collected on Kauai, where *S. ellipticum* in the present sense does not occur. According to Skottsberg it is *S. pyrularium* A. Gray. Bitter (Abh. Nat. Ver. Bremen, **14**: 433, 1900, non vide) considered the Laysan plant as *S. freycinetianum.* Rock misinterpreted the two species in his first treatment of *Santalum* (Indigenous trees of the Hawaiian islands, p. 126, Honolulu, 1913). In his second treatment (1916) he misapplied *S. ellipticum* and distributed the true *S. ellipticum* among four segregates: (1) *S. paniculatum,* which was extended from Hawaii to embrace Maui, Molokai, and Kahoolawe specimens; (2) Hillebrand's var. *cuneatum,* which was raised to specific rank and comprised Lanai and Maui plants; (3) *S. cuneatum* var. *laysanicum,* which was established for the sandalwood on Laysan; and (4) Hillebrand's var. *littorale,* which was raised to specific rank and comprised Oahu and Hawaii specimens. Skottsberg (1927) recognized five segregates: (1) *S. ellipticum,* for the small-flowered forms of Gaudichaud's species; (2) *S. ellipticum* var. *littorale,* a reduction of Rock's species, for the Oahu specimens growing near the sea; (3) *S. cuneatum,* embracing the large-flowered forms of Gaudichaud's species; (4) *S. cuneatum* f. *gracilius,* established for a sandalwood growing under favorable conditions on the Ewa plain, Oahu; and (5) *S. cuneatum* var. *laysanicum* of Rock, maintained for the

plants on the relatively isolated island of Laysan. In this paper I have reduced the last four of Skottsberg's segregates named above to the status of synonyms of *Santalum ellipticum* Gaudichaud, a single normally variable taxonomic unit, known to occur on Laysan, Oahu, Molokai, Lanai, Maui, Kahoolawe, and Hawaii.

Valuable criticism and correction of the manuscript of this paper were received from Dr. Harold St. John, University of Hawaii, and from Dr. H. F. A. Meier, Dr. R. R. Hirt, and Dr. J. Lowe of the New York State College of Forestry.

Since this manuscript was prepared, Skottsberg has stated in correspondence that he shares my opinion concerning the invalidity of *S. cuneatum.* Furthermore, Otto Degener has published a revision of Skottsberg's *ellipticum*-group (Flora Hawaiiensis, Oct. 4, 1937). Degener combines Skottsberg's *S. ellipticum* and *S. cuneatum* as *S. ellipticum* Gaudichaud. He reduces *S. ellipticum* var. *littorale* and *S. cuneatum* var. *laysanicum* to synonyms of *S. ellipticum,* an interpretation with which I agree. *S. cuneatum* forma *gracilius* of Skottsberg (which I do not maintain) becomes *S. ellipticum* var. *gracilius,* about which Degener remarks, "Some of my specimens are difficult to separate from the species proper." Degener establishes three additional segregates: (1) *S. ellipticum* forma *physophora,* abundant near the Hawaiian village at Waimanalo, previously identified by Skottsberg as *S. ellipticum* var. *littorale* which I have reduced to *Santalum ellipticum*; (2) *S. ellipticum* forma *annectens* from Kaalualu, Hawaii; and (3) *S. ellipticum* var. *luteum,* a segregate from *S. paniculatum* in Hawaii. Until more complete material is available it is impossible to evaluate these three new segregates.